US Army Corps
of Engineers
Portland District

Columbia Slough Section 1135 Restoration Project

Ecosystem Restoration Report and Environmental Assessment

April 2001

EXECUTIVE SUMMARY

S.1 AUTHORITY AND JURISDICTION

This Ecosystem Restoration Report and environmental assessment were prepared pursuant to Section 1135 of the Water Resources Development Act of 1986 (Public Law 99-662), as amended. Section 1135, P.L. 99-662, authorizes the Secretary of the Army to modify the structure and operation of water resource projects to improve the quality of the environment in the public interest. The report is in accordance with EC 1105-2-214, Project Modifications for Improvement of the Environment and Aquatic Ecosystem Restoration (dated November 1997).

The first levees were constructed by local residents primarily from 1919 until 1921. The Corps of Engineers reconstructed 53,000 feet and revetted 4,000 feet of levees along the Columbia River in these areas (now incorporated as Peninsula Drainage Districts No. 1 and No. 2, Multnomah County Drainage District No. 1 (MCDD #1), and Sandy Drainage Improvement District) between 1939 and 1941. Additional improvements and modifications were made in 1949 at MCDD #1, pump station No. 1 (near Peninsula Canal), and also restored the levee and the main pumping plant following the railroad embankment failure caused by the 1948 flood. The Corps' levee improvements also included the blockage of the locally constructed Peninsula Drainage Canal. Additional Corps work was performed between 1956 and 1961, raising the effective height of the levee by about one foot and adding a second pump station (MCDD #1, pump station #4) near 174th Avenue to evacuate flood waters from the upper end of the slough. At approximately the same time, local interests constructed a cross-levee at 142nd Avenue and added other interior drainage improvements.

The purpose of this proposed project is to restore aquatic and riparian habitat along nearly 7 miles of the middle and upper slough segments, between the two pump stations. The project will not negatively impact the original flood control project.

S.2 PROJECT BACKGROUND

The Columbia Slough represents a portion of the historic flood plain of the Columbia River extending about 20 miles eastward from the Willamette River to the Sandy River. In its natural state, the Columbia River seasonally inundated this area. A network of lakes, waterways, and wetlands spread over the entire area. It was thickly forested along shorelines and low areas, and was also made up of wetland prairie and oak savannah, bordered by riparian forest. It supported vast populations of waterfowl and other birds, elk, deer, river otter, and other smaller mammals. In the 150 years since the first settlers began to adapt the flood plain to their own uses, the area has been transformed from a natural system of lakes, sloughs, and wetlands into a highly managed water system of levees and pumps to provide drainage and flood damage reduction. Despite its urbanized nature, Columbia Slough is viewed as a valuable open space and natural resource to the Portland metropolitan area.

S.3 PROPOSED PLAN

The purpose of the proposed plan is to improve water quality and create and restore wetlands along a segment of Columbia Slough. The proposed project will consist of three main components: (1)creation of wetland benches and a meandering channel by dredging the Columbia Slough between MCDD Pump Station No. 1 (MCDD #1) and NE 158th Avenue to a designed depth, then placing the material along opposite sides of the channel to create wetland benches and a meandering low water channel; (2) replacing three culverts in Buffalo Slough and two culverts in Whitaker Slough; and (3) constructing a wetland marsh covering nine acres at Galitzski Flats near 162nd Avenue, and restoring nine acres of adjacent riparian woodland habitat at Galitzski Springs by removing invasive species and planting native species.

Little emergent marsh habitat is available along the main slough, primarily due to the steep banks and narrow channel along most of the project area. Creation of wetland benches would involve dredging Columbia Slough from MCDD #1 to NE 158th Avenue to a designed depth and placing the material along the edges of the channel to create wetland benches and a meandering channel during low water conditions. The benches would be planted to provide emergent wetland and riparian scrub-shrub wetland vegetation.

Undersized, blocked, deteriorated, and/or high invert elevation culverts are restricting flow in Buffalo Slough and Whitaker Slough. These flow restrictions increase hydraulic retention time and raise water surface elevations. The stagnant water provides favorable conditions for high water temperatures and severe algal blooms, leading to poor water quality and aesthetics. Culverts will be replaced to decrease water residence time in the slough to improve water quality conditions.

The 19.1-acre Galitzski Flats / Springs site, located east of NE 162nd Avenue between Airport Way to the north and the Union-Pacific Railroad right-of-way to the south, consists of a 9.4-acre low-lying field (Galitzski Flats) dominated by reed canary grass and a 9.7-acre heavily vegetated sideslope (Galitzki Springs) incised by several small drainages associated with perennial springs. Galitzski Flats was originally a permanent open water body (Duck Lake) that was drained in the early 1920s. Restoration would focus on re-creating wetland and open-water habitat in the Galitzki Flats, and increasing forest cover, improving age-distribution of trees, and snag recruitment in Galitzki Springs.

The estimated project construction costs are $3,685,000 (October 2000 price levels and conditions). Plans and specifications are estimated to cost $262,000, for a total project cost of $3,947,000. Fully funded implementation costs (primary construction extending from summer 2001 through summer 2004) are estimated at $4,348,000.

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1.1 Project Authority. This report is prepared under the authority of Section 1135 of the Water Resources Development Act of 1986 (P.L. 99-662), as amended. Section 1135, P.L. 99-662, authorizes the Secretary of the Army to modify the structure and operation of water resource projects to improve the quality of the environment in the public interest.

1.2 Study Purpose and Scope._ This report is a final response to the Section 1135 study authority and addresses the need for and desirability of undertaking a plan for habitat restoration within the Columbia Slough watershed. The proposed plan includes actions along 7 miles of Columbia Slough, its southern arms (Buffalo Slough and Whitaker Slough), and the surrounding riparian area. Analyses presented in this report were primarily conducted in the Columbia Slough General Investigation study, which was terminated on May 19, 2000. The General Investigation study was sponsored by the City of Portland, Bureau of Environmental Services (BES), with additional contributions by the Multnomah County Drainage District No. 1 (MCDD).

1.3 Project History. Columbia Slough represents a portion of the historic flood plain of the Columbia River extending about 20 miles eastward from the Willamette River to the Sandy River (Figure 1) In its natural state, the Columbia River seasonally inundated this area. A network of lakes, waterways, and wetlands spread over the entire area. It was thickly forested along shorelines and low areas, and was also made up of wetland prairie and oak savannah, bordered by riparian forest. It supported vast populations of waterfowl and other birds, elk, deer, river otter, and other smaller mammals. In the 150 years since the first settlers began to adapt the flood plain to their own uses, the area has been transformed from a natural system of lakes, sloughs, and wetlands into a highly managed water system of levees and pumps to provide drainage and flood damage reduction. Forested habitat has declined from about 3,600 acres in 1935-1936 to about 1,400 acres in 1991.

To promote floodplain use, local property owners established four drainage districts in 1917 and constructed levees to protect their lands from high water in the Columbia River. This effectively cut off the entire Columbia Slough from any Columbia River water supply. However, within a few years, the Peninsula Canal was dug by private interests to reconnect the lower slough to the Columbia River for flushing and navigation purposes.

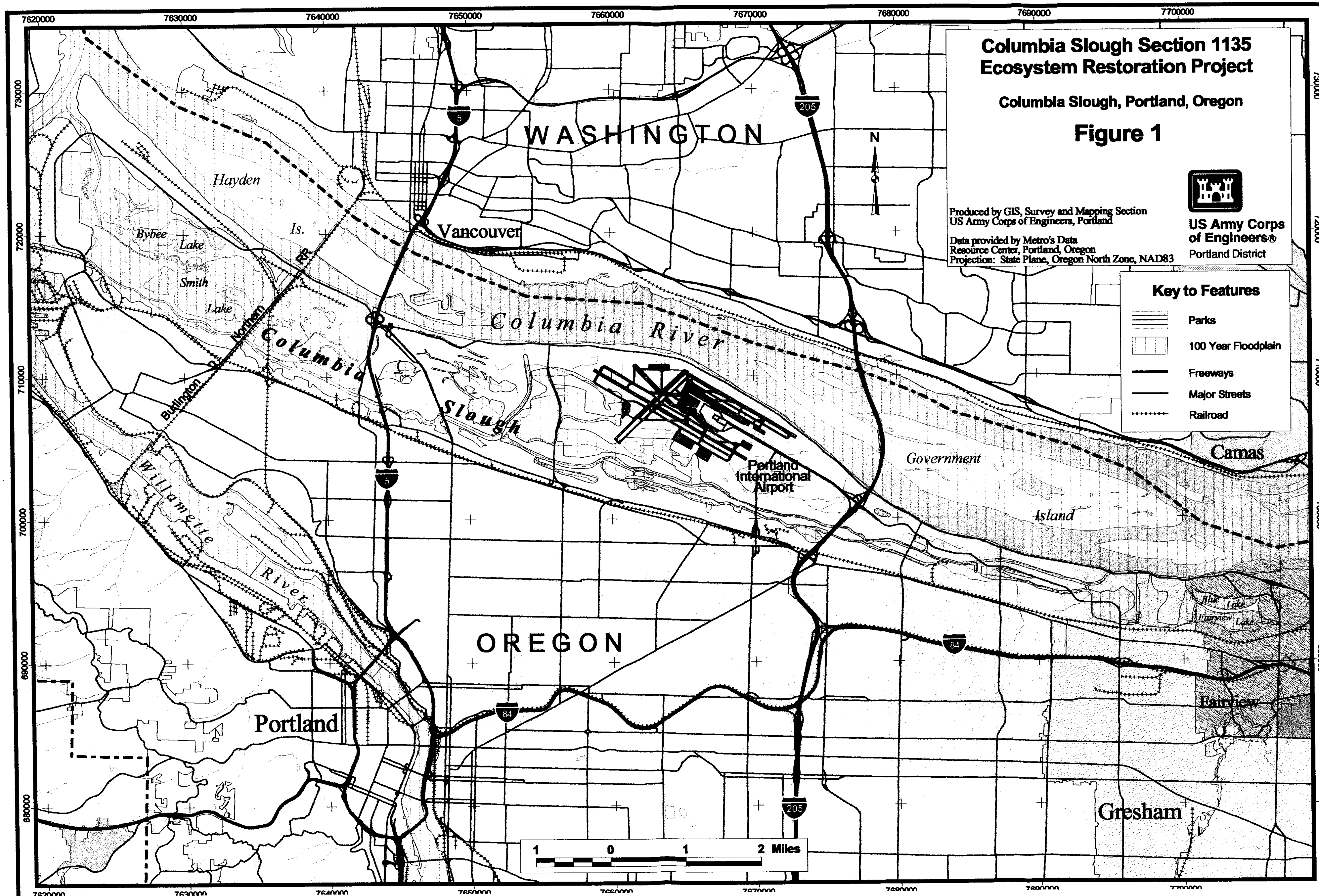
The first levees were constructed by the drainage districts primarily from 1919 until 1921. The Corps of Engineers reconstructed 53,000 feet and revetted 4,000 feet of levees along the Columbia River in these areas (now incorporated as Peninsula Drainage Districts No. 1 and No. 2, Multnomah County Drainage District No. 1 (MCDD #1), and Sandy Drainage Improvement District) between 1939 and 1941. In 1949, the Corps improved MCDD #1, pump station No. 1 (near Peninsula Canal) by reconstructing the outlet structure, upgrading the pumps and adding a new tide box. The Corps restored the levee and the main pumping plant following the railroad embankment failure caused by the 1948 flood. The Corps' levee improvements also included the blockage of the locally constructed Peninsula Canal. Additional Corps work was performed between 1956 and 1961, raising the effective height of the levee by about one foot and adding a second pump station (MCDD #1, pump station #4) near 174th Avenue to evacuate flood waters from the upper end of the slough. At approximately the same time, local interests constructed a cross-levee at 142nd Avenue and added other interior drainage improvements.

The lower Columbia Slough (lower 8 miles) is still heavily influenced by backwater from the Willamette River. Upstream of the Peninsula Canal and MCDD pump station No. 1, Columbia Slough is a heavily managed water system, with no connection to the Columbia River except by pumping from the slough at MCDD #1 pump stations No. 1 and No. 4 (west of NE 185th). The area is heavily industrialized, with the last remaining agricultural areas in the upper slough converting to commercial properties. There are a few areas designated as Conservation and Preservation zones, together with some mitigation wetlands in the upper slough. The entire watershed receives stormwater from urban areas south of Columbia Boulevard.

1.4 Resource Problems. This plan is one aspect of an overall Columbia Slough Revitalization Program being conducted by the City of Portland. This program includes combined sewer overflow (CSO) removal, assessment of health risks from sediment contamination, and a water quality program which addresses stormwater quality issues and eutrophication (which the Corps' program primarily addresses through flow management and habitat restoration).

The Columbia Slough is a designated water quality limited waterbody under the Federal Clean Water Act (CWA) and Oregon Revised Statues (ORS 468.730). Over 100 stormwater outfalls (many of them municipal) discharge into the Columbia Slough. In particular, the CWA prohibits the unpermitted discharges of stormwater into jurisdictional waters, such as the Columbia Slough. Stormwater and groundwater, contaminated by old septic systems in the Mid-County area, are the principal flow inputs into the system. The majority of the watershed is designated as the Columbia Corridor, and has extensive industrial land-use. Industrial developments front on the both sides of the Columbia Slough, with both permitted and illicit industrial discharges entering the Slough. As a result of the above activities and past management practices, water quality of the Columbia Slough is impacted by municipal stormwater and industrial discharges, combined sewer overflows (CSOs), and contaminated groundwater.

A consent decree, resulting from a 1986 citizen lawsuit, required the Oregon Department of Environmental Quality (ODEQ) to develop Total Maximum Daily Pollutant Loads (TMDLs) for the Columbia Slough. In 1992, the City and ODEQ signed a Memorandum of Agreement (MOA), #27752, which committed the City to a detailed water body assessment of the Slough and to City compliance with TMDLs, established from this assessment, within 10 years.



Columbia Slough Section 1135
Ecosystem Restoration Project
Columbia Slough, Portland, Oregon
Figure 1
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland
Data provided by Metro's Data
Resource Center, Portland, Oregon
Projection: State Plane, Oregon North Zone, NAD83
US Army Corps of Engineers®
Portland District
Key to Features
Parks
100 Year Floodplain
Freeways
Major Streets
Railroad
WASHINGTON
OREGON
Hayden
Is.
Bybee
Lake
Smith
Lake
Vancouver
Columbia River
Columbia
Slough
Burlington Northern RR
Willamette
River
Portland International Airport
Government
Island
Camas
Blue Lake
Fairview Lake
Fairview
Portland
Gresham
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The water body assessment was completed in November 1995. The assessment provided the information needed to develop the TMDLs for the Columbia Slough. In addition, a consent order was signed between the City and ODEQ (ESR-NWR-93-09) to assess the nature and extend of sediment contamination in the Slough, which has resulted in a screening level risk assessment. The waterbody assessment identified stormwater as a potential source of metals discharge into the Slough. The screening level risk assessment identified some metals and organics as a risk to humans and the environment.

In June 1997, BES initiated an independent scientific peer review of the Columbia Slough Sediment Project. While toxic contamination poses increased human health cancer and non-cancer risks, the reviewers felt strongly that eutrophication and habitat destruction were more severe and pervasive threats to the fundamental structure and function of the Slough ecosystem than toxic contamination. If all threats from toxic contamination were eliminated, the Slough would still be a highly degraded, highly altered ecosystem that lacked many of the desirable qualities of a natural system. In contrast, addressing some of the broader threats to the Columbia Slough ecosystem may simultaneously reduce the impact of toxic contamination. Consequently, the study addresses eutrophication and habitat restoration issues.

1.5 Prior Studies and Reports. Many studies have been conducted for the Columbia Slough watershed. This list is a partial compilation, listing major reports relevant to the conclusions in this study. Additional references are listed after the conclusion of this report.

Bureau of Environmental Services (BES). 1988. *Columbia Slough Water Quality Management Plan, Water Quality Report.* City of Portland, Bureau of Environmental Services. September 1988.

Bureau of Environmental Services. 1995. *Environmental Assessment, Columbia Slough Revitalization Program.*

Department of Environmental Quality (DEQ). 1998. *Total Maximum Daily Load (TMDL) for: Chlorophyll a, Dissolved Oxygen, pH, Phosphorus, DDE, DDT, PCBs, Pb, fecal coliform and 2,3,7,8 TCDD in the Columbia Slough.*

U.S. Army Corps of Engineers, Portland District. July 1992 (Revised August 1993). Columbia Slough Reconnaissance Study.

1.6 Expected Successes. The project site has a high likelihood of successful restoration for the following reasons: (1) creation of a meandering channel in 1989 using dredged material, similar to that proposed for Columbia Slough, successfully created emergent wetlands in Whitaker Slough east of NE 122nd Avenue; (2) modeling of the modified culverts in Buffalo Slough and Whitaker Slough indicated decreased residence time, reduction in eutrophication, and increased areas for emergent wetland habitat; (3) the constructed wetland at NE 162nd Avenue is adjacent to mitigation wetlands, as well as Preservation and Conservation zones; and (4) the Galitzski Springs restoration site still has extensive woodlands habitat which can be restored, and it is adjacent to the wetland mitigation sites and Preservation Zones.

Flood levels were modeled to determine the effect of the proposed wetland benches. The wetland benches had no effect on flood levels. Modification of the culverts in Buffalo Slough and Whitaker Slough will reduce water levels. The wetlands at NE 162nd, as well as the riparian restoration area at Galitzski Springs, are off-channel and will result in no increase in flood levels.

SECTION 2. PLANNING AND OBJECTIVES

This feasibility study has been prepared by the U.S. Army Corps of Engineers, Portland District (Corps) for environmental restoration of the Columbia Slough in north Portland, Oregon. This project was initially a General Investigation (GI) study, sponsored by the City of Portland. The Feasibility Cost Sharing Agreement (FCSA) was signed on October 6, 1998. Early in the study process, it became apparent that the more expensive alternatives would not provide sufficient environmental benefits to be feasible. Other alternatives were suggested for investigation by the local sponsor and by the Multnomah County Drainage District No. 1 (MCDD #1), which manages the area of the proposed projects.

The proposed projects were less expensive than those originally proposed in the GI study and would be more appropriate under Section 1135 authority. The project is linked to past Corps actions in that it is located within a Corps levee system. After Congress did not appropriate any funds for the study for Fiscal Year (FY) 2000, it was suggested to the City of Portland that the project be conducted under Section 1135 authority. This would reduce the non-Federal cost share from 35% under GI authorization to 25%. The reduced cost of the proposed project is within the cost criteria for this authority. Initial city costs would also be reduced since the Section 1135 feasibility study is initially 100% Federally funded. The project could be reviewed and approved at the division level, expediting the process to reach construction.

The overall purpose of the feasibility study is to investigate and recommend ecosystem restoration alternatives for Columbia Slough which would: rehabilitate the hydrology and channel form of the Slough to create wetland bench habitat for waterfowl and turtles; establish conditions favorable to native emergent wetland vegetation and native fauna; decrease habitat degradation caused by water quality impairment (excessively high temps and low DO); and provide a channel structure and hydrology that mimic elements of a lowland side-channel off a large river. The restoration activities were evaluated for their effect on operation of MCDD #1 for flood control, vegetation management, pumping, irrigation management, water quality, and other maintenance. Potential recreational and educational opportunities based around seasonal variability will also be investigated.

2.1 General Criteria.

- The proposed modifications are consistent with the authorized purpose of flood control by the Lower Columbia River Basin Levees and Improvements at Multnomah County Drainage District (MCDD) .
- The proposed work is compatible with other ongoing efforts by Federal, state, and local agencies.
- Public health, safety, and well-being will be protected.
- Analyses of benefits and costs are to be conducted in accordance with Corps regulations and must ensure that any plan is complete, efficient, safe, and economically feasible in terms of current prices.

2.2 Technical Criteria.

- The with-project condition will not worsen flood control capability for MCDD #1 or for the local sponsor (BES).
- The project should be designed to minimize the amount of regular maintenance required for the non-Federal sponsor.
- The project will support other watershed water quality mitigation and restoration efforts being conducted in the watershed by other Federal, state, and local agencies.

2.3 Environmental and Social Criteria.

- The project will create or improve floodplain wetland and upland forested habitat that will provide feeding, perching, and nesting habitat for wildlife.
- Invasive non-native plant species will be removed and/or controlled.

SECTION 3. EXISTING CONDITIONS

3.1 Water Quantity. The Columbia Slough Watershed is typically broken into four reaches (Figure 2): the Lower, Middle, and Upper Sloughs and the Fairview Creek watershed. The Lower Slough extends from the mouth at the Willamette River to Multnomah County Drainage District Pump Station No.1 (MCDD#1). The Lower Slough is tidally influenced and subject to stormwater discharges. Between the months of December and July, the water levels in the lower slough are generally several feet higher than in the Middle Slough. When Lower Slough water levels exceed those in the Middle Slough, flow is prevented from entering the Middle Slough by tide gates through the levee at MCDD pumps station #1. The bulk of flow to the Lower Slough is derived from the pumped flows from Peninsula Drainage Districts Nos.1 and 2 and the stormwater from North and Northeast Portland. The Lower Slough is also hydraulically connected to Smith and Bybee Lakes. Projects to virtually eliminate combined sewer overflows to the Lower Slough have been implemented.

The Middle and Upper Sloughs flow primarily west through a series of parallel channels, which are broken up into several narrow ponded segments separated by road crossings and culverts. The Middle Slough extends from MCDD#1 to the Mid-Dike levee just west of NE 142nd Avenue, and receives stormwater and the bulk of groundwater flows into the slough. The Upper Slough extends from the Mid-Dike to Fairview Lake and receives stormwater and flows from Fairview Lake. During flood events, flood waters drain to two existing pumping stations (pump station #1 on the west and pump station #4 on the east, near NE 185th Avenue). The cross-levee provides additional protection for Portland International Airport (on the west) from the principal flood waters originating from the Upper Slough and Fairview Lake. The cross levee has positive closure structures that allow control of the interchange of flows. The Middle Slough also has a south arm system of sloughs (Buffalo and Whitaker Sloughs) which interconnect with the main north arm. Fairview Creek and Lake watershed is usually considered the fourth reach in the slough system.

Most of the groundwater comes from regional aquifers that are recharged from upland areas south of the Slough. Groundwater is the primary source of flows to the slough during the summer months.

3.2 Flow Management. Flow control and maintenance of the drainage system and facilities in the Columbia Slough mainly fall to the Multnomah County Drainage District (MCDD), the City of Portland, the City of Gresham, and the Village of Fairview. MCDD is responsible for drainage on the south shore of the Columbia River between the river and (generally) Columbia Boulevard and between MCDD#1 to Fairview Lake, including Portland International Airport and Blue Lake Park. The City of Gresham and the Village of Fairview have jurisdiction over stormwater flow in the Fairview Lake watershed. The City of Portland has jurisdiction over stormwater originating in areas of the watershed generally south of Columbia Boulevard, in the combined sewered area, and in newly separated areas (from the combined sewers in the Lower Slough reach). The Metropolitan

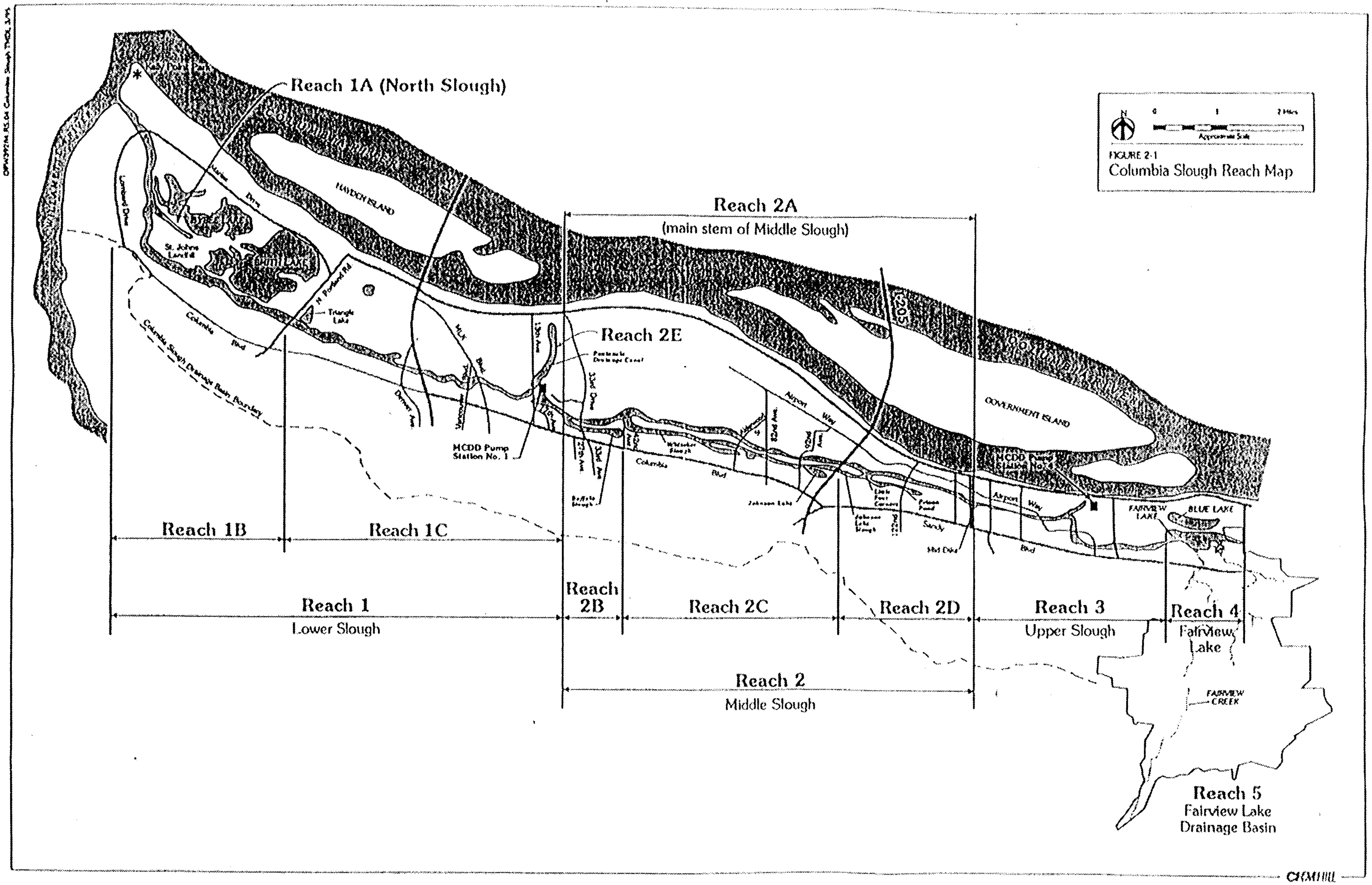


FIGURE 2-1
Columbia Slough Reach Map

Service District (Metro) has jurisdiction over management of Smith and Bybee Lakes in the Lower Slough. The City of Portland has primary responsibility for the water quality management of the Columbia Slough within the city limits.

3.2.1 Summer. Gate structures at the cross-dike levee are used to separate the middle and upper slough areas into separate hydrologic basins during the summer months, typically June to mid-October. The water elevations are maintained around 8.0' to 9.0' NGVD in the upper slough. MCDD typically maintains these elevations by pumping at pump station #4, and also has the option to meter the flows at the cross levee by partially opening the slide gates and allowing the water to go to pump station #1. The higher water elevations are necessary for irrigation and wetlands.

The water elevation in the middle slough is typically maintained between 5.0' to 6.0' NGVD by pumping at pump station #1. When the Columbia River elevation drops below elevation 4.5', flow can enter the lower slough by gravity flow.

The control structure at Fairview Lake is closed in early May to fill the lake for recreational use. The water elevation in the lake will reach elevation 11.2' before it flows over the weir dam. The control structures are re-opened in early October to drain the lake back to its winter elevations of 8.5' to 11.0'.

3.2.2 Winter. The cross levee typically remains open during the winter months unless pumping problems occur at Pump Station #1. The slough is pumped down to elevation 5.5' to 6.5' at Pump Station #1 and 7.0' to 8.0' at Pump Station #4 prior to a large storm. This is normal operating procedure for the MCDD, as it frequently loses power during heavy rain and wind events. The drawdown allows MCDD to have storage room in the slough during the outage. During a storm, water elevation is maintained between 6.0' to 8.0' at Pump Station #1 and 8.0' to 10.0' at Pump Station #4.

The pumping capacities and lowest operating elevations for each pump are shown below:

	Pump Station #1		Pump Station #4	
Pump #1	71 cfs	4.5'	150 cfs	7.0'
Pump #2	150 cfs	6.0'	150 cfs	7.0'
Pump #3	104 cfs	5.0'	150 cfs	7.0'
Pump #4	150 cfs	6.0'	150 cfs	7.0'
Pump #5	73 cfs	4.5'	---	---

3.3 Water Quality

Water quality in the Columbia Slough is a concern both for aquatic life and for human health and recreation. Unlike other free-flowing water bodies in the City of Portland, the Columbia Slough is highly managed. The upper slough is isolated by a series of dikes whose water levels are controlled by pumps and weirs. The lack of natural flushing results in accumulated sediments and raised levels of pollutants associated with the sediments.

<u>Water Quality Limited Status</u>

The State of Oregon, Department of Environmental Quality (DEQ) has listed the Columbia Slough as water quality limited for salmonid fish rearing, resident fish and aquatic life, wildlife and hunting, fishing, boating, water quality recreation, and aesthetic quality. Columbia Slough is considered water quality limited for the following parameters:

- Chlorophyll a, pH, and phosphorus from spring through fall when algae blooms are greatest
- Temperatures from spring to fall
- Dissolved oxygen criteria for cool water aquatic life throughout the year
- Bacteria throughout the year
- DDE, DDT, PCBs, and dioxin due to elevated levels found in fish tissue, impairing the use of the Slough for fishing
- Lead in the water column

These parameters affect aquatic life, human health, safety, and recreation as well as aesthetics. Sources of water quality problems in the Columbia Slough include groundwater, landfill leachate, airport deicing discharges, urban runoff, past practices, and industrial runoff.

DEQ has developed Total Maximum Daily Loads (TMDLs) for the Columbia Slough for the above parameters (except water temperature).

The following subsections outline pollutant sources as they relate to key water quality parameters:

<u>Nutrients (Phosphorus).</u> Septic systems in the eastern portion of the Columbia Slough watershed have increased nutrient levels in groundwater. Although properties are being connected to public sewers, the groundwater will continue to transport residual nutrient loads for an estimated 20 to 40 years. Nutrients are a particular problem in the summer when nutrient-rich groundwater makes up the primary flow in the middle slough and contributes to algal blooms and macrophyte growth.

<u>Temperature.</u> Temperature in the Slough is high in the spring, summer, and fall, with highest temperatures occurring during the summer months. Flood control levees and development have reduced riparian vegetation, reducing shading. This, combined with the low flows and shallow depths, results in higher water temperatures. Groundwater influx appears to help reduce temperatures in the southern arms of the middle slough, but has little effect on the lower slough.

Dissolved Oxygen (DO). The primary causes of low dissolved oxygen levels in Columbia Slough have been winter deicing activities and summer algae growth. In the past, airport crews at Portland International Airport, located adjacent to the Columbia Slough, have deiced airplanes when necessary; the deicing material mixed with stormwater and discharged the wastewater to the slough. The diluted deicers start to biodegrade and affect the levels of DO within the slough. (The Port has modified its operations to minimize this problem, implementing Best Management Practices to reduce the discharge of deicing materials. The Port is also in the process of constructing temporary storage tanks and detention basins.) In summer, algae growth contributes to large DO fluctuations, as algae photosynthesize and produce oxygen during the day and respire and give off carbon dioxide during the night. However, dissolved oxygen levels are not completely depleted in the summer months.

pH. Low pH levels can result in increased solubility of some constituents, particularly metals, and are generally unfavorable to aquatic organisms. High pH levels can increase the toxicity of ammonia to fish and result in other negative impacts to biota. The allowable pH level is 6.5 to 8.5. During the summer, high pH seems to be a function of eutrophication and photosynthesis. pH is primarily a problem in the upper slough in spring, summer, and fall.

Toxics (DDE, DDT, PCBs, Dieldrin, Dioxin). A variety of toxic substances are found in the Columbia Slough , including: DDT and dieldrin, pesticides widely used and dispersed years ago; dioxins, a by-product of many manufacturing processes, and also found in sludge from municipal sewage treatment plants; and PCBs, once used in insulating fluids in electrical equipment, as well as in plasticizers, lubricants, and hydraulic fluids. Although the use of DDT, dieldrin, and PCBs has been banned for decades, these compounds are highly persistent and are still present in water, soil, sediment, biota, and the atmosphere. In the Columbia Slough they are most concentrated in fish tissues, presenting significant human health risks. They will probably continue to enter water bodies as contaminant-laden soils that are eroded and washed into surface waters with each storm. In addition, aquatic sediments represent a historical reservoir that continues to supply contaminants to surface waters and biota.

Metals: Stormwater is the largest contributor of lead, the primary heavy metal of concern in the Columbia Slough Watershed. Other sources include industrial discharges, historic combined sewer overflows (CSOs) in the lower slough (outside the project area), contaminated sites, contaminated sediments, air emissions, and St. Johns Landfill.

Bacteria (Fecal Coliform). The highest bacteria concentrations recorded have been found in the lower slough during winter months and are associated with CSOs. However, the CSOs are being rerouted so that they do not flow into the slough, so this problem will be minimized. Bacterial contamination in the middle slough occurs in summer, fall and winter, possibly due to failing septic systems and illicit connections to the storm system. In the upper slough, stormwater appears to be the main source of bacteria.

3.4 Sediment Quality

The Columbia Slough has received untreated sewage, industrial waste, untreated stormwater, contaminated groundwater, and agricultural runoff containing pesticides for decades. As a result, harmful pollutants have accumulated in sediments on the Slough bottom. A Screening Level Risk Assessment (SLRA) was completed in response to the October 1993 consent order between DEQ and the City of Portland that required investigation of sediment contamination in the Columbia Slough. The SLRA was a comprehensive investigation of the sediments throughout the entire Columbia Slough, with the goal to rank sites according to their potential risks to human health and the environment, identify the highest priority sites, and remove from consideration those contaminants and exposure pathways (e.g., dermal contact) that clearly do not pose risks.

Follow-up investigations at Buffalo Slough found that significant risks to human health were found from PCBs, chlordane, arsenic, and DDT in fish tissues. The study also found significant risks to benthic organisms, primarily from copper and lead in sediments. No significant risks to wildlife were found. At Whitaker Slough, significant risks to benthic organisms were found due to pesticides in sediments. Because no fish of catchable size are present in this portion of the slough, there is no possibility for human exposure to fish tissues contaminants, and therefore there is no risk to humans.

Historical data from the main Slough were reviewed to evaluate potential sediment issues related to in-water disposal (side casting) of Slough sediments. Numerous surface samples had been taken in the Slough mainstem on various dates and at numerous locations. Most of the analyses were below the screening levels (SLs) of the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). Table 1 in Appendix A shows the exceedances of the SLs. Those analyses exceeding the SLs were four heavy metals, three phenol groups, two phthalate groups, one alcohol and two pesticides.

After the review was conducted, additional sampling was conducted by the Corps of Engineers to characterize the sediment of portions of the middle and upper Columbia Slough mainstem (Appendix A). The chemical testing indicated that the only contaminant exceeding the DMEF screening levels was DDT. DDT levels were highest upstream of the 'Four Corners' area near MCDD Pump Station #4. Subsequent biological testing indicated no risk for bioaccumulation in wildlife or humans. This information was presented at a meeting of the Dredged Material Management Team (DMMT) on 18 February 2000. The DMMT indicated its belief that placement of dredged material within the channel boundaries would be acceptable in the reaches downstream of the Four Corners area. The wetland benches were proposed to end at NE 158^{th}, downstream of this area.

3.5 Vegetation. The variety and abundance of wildlife resources in an area is highly dependent on the type and distribution of vegetation. Historically, the Columbia Slough was thickly forested along the shores and low-lying areas. It contained expanses of wetland prairie and oak savanna.

Along the 60 miles of stream bank in the Slough, one-third is used for residential, about one-half is commercial/industrial, and the remainder is vacant, parks and open space. During the last 60 years, habitat areas (open water, tree/thicket cover, marsh/wetlands) have been reduced from almost 50 percent of the vegetation cover in the watershed to less than 20 percent. The remaining habitat is primarily in the riparian areas and consists of reed canarygrass adjacent to the Slough or in the Slough itself.

Species such as willow, ash, cottonwood, alder, dogwood, rushes, sedges, wapato, iris, and elodea are common native plants in wetland areas. Invasive species, including Himalayan blackberry, reed canarygrass, smartweed, curly dock, cattail, and duckweed are common non-native competitors. Upland species include cottonwood, red alder, hawthorn, dogwood, oak, snowberry, nettles, Oregon grape, oceanspray, and sword fern. Invasive species include blackberry, thistle, fireweed, chickory, ragwort, and several species of mustard.

In most areas, the riparian corridor is a continuous but narrow strip of land immediately adjacent to the Slough itself. Much of the riparian area contains buildings or paved surfaces. Since 1995, BES has undertaken an aggressive program to restore and replant the riparian area with native vegetation.

3.6 Wetlands

Historic wetlands have been diminished by agriculture, flood protection, and urban/industrial development. The types that remain are forested wetlands dominated by cottonwood and ash; diked agricultural fields that flood seasonally; and more traditional emergent wetlands containing rush, sedge, and cattail. Smith and Bybee Lakes (2,000 acres) in the lower slough reach form the best habitat area in the Slough and are the most significant wetland complex in the City. Mitigation wetlands have been developed, primarily in the upper and lower slough.

3.7 Fish and Wildlife.

Most of the wildlife associated with the Columbia Slough occurs in riparian wooded habitats, in and around the reed canarygrass, or in the Slough itself.

Waterfowl species, such as ruddy duck, scaup, mallard, American widgeon, cinnamon teal, green-winged teal, wood duck, canvasback, gadwall, hooded merganser, common merganser, northern shoveler, and shoveler, are common users of the slough habitat, particularly in winter. In spring, some waterfowl nesting also occurs. American bitterns, green herons, and black-crowned night herons are also. In general, waterfowl populations are declining as a result of habitat loss. Shorebirds, such as western sandpiper, least sandpiper, spotted sandpiper, killdeer, great blue heron, and greater yellowlegs, are found along the shoreline of the lakes and ponds in the area.

A variety of songbirds inhabit the forested and reed canarygrass riparian areas. Among them are the cedar waxwing, common yellowthroat, orange-crowned warbler, and the American goldfinch. Other species include oriole, warbler, peewee, sparrow, towhee, wren, jay, thrush, yellowthroat, swift, swallow, finch, waxwing, blackbird, snipe, flycatcher, harrier, kestrel, kingfisher, owl, and hawk. Bald eagle (threatened) and peregrine falcon forage in the slough. Tricolor blackbird and willow flycatcher are candidates for listing under ESA regulations. Upland birds include valley quail, ring-necked pheasant, and mourning dove.

Historically, the Slough was populated by elk, deer, river otter, and other small mammals. Elk have since disappeared. All remaining wildlife exhibits considerable adaptation to human presence. The Slough provides habitat for populations of muskrat, nutria, beaver, gray squirrel, chipmunk, fox, skunk, rabbit, opossum, weasel, raccoon, and other rodents. Shrews and moles are also likely.

Tree frogs, bull frogs, newts, yellow racers, alligator lizards, garter snakes, and pond and painted turtles are common in the Slough.

Aquatic invertebrates include varieties of cladocerane, rotifers, oligochaete worms, chironmid larvae, clams, and a few midge fly larvae. The existing habitat for macroinvertebrates/benthic organisms is poor because of the silty nature of the Slough's sediments. The silts are often devoid of oxygen and do not offer a suitable habitat for many benthic organisms. Consequently, benthic organisms are not very abundant.

Macrophytes, or water weeds, have flourished in the middle slough during the past few years. In 1994 and 1995, MCDD #1 maintained low water surface elevations in the middle slough to reduce residence time in the slough, thereby reducing summer algal blooms. Initially, the low water level resulted in significantly clearer water in the slough, which enabled water weeds to grow. The weeds have nearly choked flow in the middle slough, raising concerns about flood control and BOD loading in the fall season when the weeds break off and float downstream.

The Columbia Slough is riverine, with unconsolidated mud substrate. Some sandy bottom sections exist in the lower slough near the Willamette River. These substrates, together with slow flows and elevated water temperature and pollutant levels, translate to limited habitat for cold water fish. Juvenile salmonids have been found in the lower slough during the spring but not during the summer or fall. Salmonid spawning in the Slough has not been observed or documented and probably could not occur because of the lack of suitable spawning habitat, which requires gravel substrate. There are no traditional pools and riffles in the Slough because of its limited gradient. Currently, fish passage through the Slough is blocked by flood control structures in the middle and upper sloughs.

A report titled *Columbia Slough Master Plan, Task Report, Fish and Biological Studies, Fish and Fish Habitat* (Fishman Environmental Services, 1988) characterizes fish population and maps fish habitat along the Columbia Slough and describes the effects of water quality on this resource. The report documented the presence of at least 17 species of fish that had been identified in the Columbia Slough system. Game fish found in the Slough included black and white crappie, blue gill, yellow perch, brown bullhead, warmouth, large mouth bass, chinook salmon, and white sturgeon. Non-game species included large-scale sucker, carp, goldfish, three-spined stickleback, peamouth, and cottid (sculpin). Other fish species noted included squawfish, catfish, and pumpkinseed. Recreational anglers are known to fish for several species, including crappie, bass, catfish, perch, and carp.

3.8 Threatened and Endangered Species. The proposed plan includes actions along 7 miles of Columbia Slough, its side sloughs, and the surrounding riparian area. The affected area of Columbia Slough is upstream of the Peninsula Drainage Canal and MCDD pump station #1. This segment of Columbia Slough is not connected directly to the Columbia River or the Willamette River, except by pumping from the slough at MCDD Pump Station #1 (to lower Columbia Slough, which connects to the Willamette River) and from MCDD Pump Station #4 (to the Columbia River, west of NE 185$^{th)}$. The area is heavily industrialized, with industrial developments lining both sides of the slough. The last remaining agricultural areas in the upper slough are converting to commercial properties. Water levels in the slough are managed with a system of levees, dikes, slide gates, and pumps. Thirteen combined sewer overflows formerly discharged into the lower slough, until the 12-ft diameter interceptor pipe project was completed in 2000. Over 100 stormwater outfalls (many of them municipal) discharge into the slough. The waterway receives stormwater from urban areas south of Columbia Boulevard. This segment of Columbia Slough is considered ecologically stressed, with fragmented habitat, high levels of macrophytes and poor benthic invertebrate species diversity. The Columbia Slough is a designated water quality limited waterbody under the Federal Clean Water Act and Oregon Revised Statutes (ORS 468.730).

The aim of the project is to increase channel complexity, provide a hydrologic period that more closely mimics historic off-channel sloughs, and restore riparian, shrub-scrub, emergent, and aquatic bottom habitats. The actions would create conditions favorable to native emergent wetland vegetation and native fauna, and would improve floodplain wetland and upland forested habitat that would provide feeding, perching, and nesting habitat for wildlife.

The project area was evaluated for potential effects to ESA-listed wildlife, plant and fish species. There is no suitable habitat in the project area for any threatened or endangered plants historically known to occur in this portion of the Willamette Valley, i.e., golden Indian paintbrush (*Castilleja levisecta)*, Bradshaw's lomatium (*Lomatium bradshawii*), Nelson's checker-mallow (*Sidalcea nelsoniana*), Willamette daisy (*Erigeron decumbens var.decumbens*), and Kincaid's lupine (*Lupinus sulphureus var. kincaidii*). The area is severely modified from natural conditions and is highly developed and occupied by dense industrial or other establishments. Undeveloped areas are occupied by reed canarygrass (*Phalaris arundinacea*), Himalayan blackberry (*Rubus discolor*), and other invasive weedy species.

Bald eagles (*Haliaeetus leucocephalus*) are occasionally seen along the Columbia River, but the Columbia Slough does not provide suitable foraging, breeding, nor wintering habitat for the species. The only bald eagle nest site within 5 miles of the proposed project area is on Government Island, greater than 0.75 mile (1.2 km) north of Columbia Slough. It is highly unlikely that bald eagles forage on Columbia Slough due to the lack of potential perch trees and the high level of industrial and other development. The Columbia River, as well as the sloughs, lakes, and ponds on Government Island, provide favorable foraging habitat for the birds occupying the nesting territory. In addition, there are no documented bald eagle winter roosts within the vicinity of Columbia Slough.

The area is not occupied by threatened or endangered Columbia River salmonids. While such species have been documented downstream near Smith and Bybee Lakes, the reach of Columbia Slough upstream of MCDD Pump Station #1 is inaccessible to salmon. Discussions with the National Marine Fisheries Service (NMFS) indicated that NMFS did not have concerns with the proposed actions in Columbia Slough, as long as the actions did not affect the reach downstream of MCDD Pump Station #1.

The project site was visited by staff from the Oregon Department of Fish and Wildlife (ODFW) to determine the potential impacts on native turtle populations in the area. Ideally, native turtles (western pond turtle, painted turtle) prefer slow moving streams and backwater ponds that provide adequate food, cover, basking sites and nearby adjacent upland nesting habitat for their life requirements. They are listed as Sensitive Critical in Oregon. The enhancements in Columbia Slough should improve the aquatic habitat for native turtles by increasing the native vegetation component, thus improving food availability; providing and increase in the number of basking structures (logs and sparsely vegetated banks); and providing open, sparsely vegetated banks in some areas for nesting habitat and for adequate incubation of eggs. The project enhancements should improve both the quantity and quality of available habitat for turtles.

Based on this information, it is determined that the proposed water resource project on the Columbia Slough would have no effect on any listed or proposed threatened or endangered species.

3.9 Cultural Resources. Historically, the Fall 1805 and Spring 1806 visits by Lewis and Clark identified two active Native American villages near the existing Airport Way Urban Renewal Area. One is at the present airport location, and the other is near Blue Lake Park. Fishing and gathering of cattail, wapato, and rushes were common historical activities. Since the late 1800s, the Columbia Slough was predominantly flood plain agriculture, with levees and cross dikes constructed in the early 1900s. By the mid-1900s, crop farming succeeded dairy farming as the dominant use of the flood plain.

Most of the area along the middle and upper Columbia Slough has been zoned industrial, with various environmental overlays: scenic, preservation, and conservation. Several zoning restrictions apply to development within this zone/overlay designation. Portions of the Columbia Slough embankment area have been included in the city's 40-Mile Loop trail system, though portions remain undeveloped.

Recreation along the middle and upper slough is limited by difficult access, poor water quality and commercial and industrial development. Activities include fishing, wildlife viewing and canoeing. Some swimming has been reported in Whitaker and Buffalo Sloughs and the lower Columbia Slough, although water quality is such that swimming has not been recommended, primarily due to historic CSOs. Some fishing occurs, primarily for warm-water species such as bass, crappie, catfish and carp. Poor water quality and water level fluctuations limit fishing opportunities. Hiking and bird-watching occur along the slough on both private and public property (Portland BES, 1995).

Smith and Bybee Lakes also provide opportunities for bird watching, fishing, and boating. Delta Park, located east of Interstate 5, provides extensive recreational opportunities, including, softball, volleyball, and soccer playing areas. The Ramsey Lake Constructed Wetland offers bird-watching activities, as well as educational opportunities. Other developed public recreational sites include Kelley Point Park, Pier Park, Johnsonwood Park, East and West Delta Parks, Whitaker Ponds, Blue Lake, and the Expo center. Private facilities include Portland Meadows, Portland International Raceway, and five golf courses: Broadmoor, Colwood, Columbia Edgewater, Riverside, and Heron Lakes (the first four are private and the fifth is a public course). Marine Drive is a scenic route, and the cross-dike at NE Sandy Boulevard and NE Marine Drive is recognized for its outstanding views.

The project area was inventoried for cultural resources by Heritage Research Associates (HRA) of Eugene, Oregon, under contract with the Corps. The inventory involved an intensive literature search to identify known and expected cultural resources within the project area and an intensive surface and subsurface examination along the interior of the dikes bounding the north side of Columbia Slough.

The area bounding the Columbia River Slough is noted for its dense concentration of prehistoric archeological sites. These sites are frequently associated with the high ground surrounding low marshy ponds. The association of archeological sites with high ground is a result of the repeated use of certain areas by Native Americans to procure resources associated with marshy habitat including plants (such as wapato), migratory waterfowl and other animals. (Butchard, February 1990:15; Musil and Toepel, September 3, 1993:3) Low marshy ground is also associated with stream courses that provided access to this area by canoe, a favored method of Native American transportation along the lower Columbia River.

Butchard estimates that over 70 percent of the archeological sites within the Columbia South Shore area (roughly the area bounded by the Columbia River on the north, the Columbia Slough on the south extending from the Willamette River to the Sandy River) are within 50 feet of water. He also finds that at least 20% of known sites are associated with marshy habitat. (Burtchard, February 1990:32)

Archeological surveys have been conducted in the South Shore area but the area proposed for the Galitzki Flats restoration has not been surveyed. Archeological sites are found in the immediate vicinity of the project area and relatively close to Galitzki Flats. Eastward of Galitzki Flats more than 10 prehistoric sites have been identified. (The high site density to the east of the project is a result of intensive cultural resource investigations in this location.) The high site density bounding the project area indicates intensive Native American settlement and resource procurement. Thus, it is reasonable to expect additional cultural resources within or immediately adjacent to Galitzki Flats. Prior to restoration activities, Galitzki Flats area would be surveyed for cultural resources by a professional archaeologist who is familiar with the cultural resources of the South shore area. Based on the results of this survey, additional cultural resource efforts may be necessary to preserve or mitigate project impacts to important cultural resources within the project area.

3.10 Social and Economic Setting. Columbia Slough is located in Multnomah County in northwest Oregon. Portland, the largest city in the state, is located in Multnomah County. Multnomah County has the highest population density in Oregon.

Since 1984, growth patterns in the City of Portland have been molded by the policies of the Oregon Land Conservation and Development Commission, resulting in the establishment of an urban growth boundary (UGB). Metro, the regional planning agency, has worked with represented jurisdictions to plan, contain, and provide services for this future growth within the UGB. As a result, significant infill is projected within the City's USB.

Development in the western and central portions of the Columbia Slough Watershed has been significantly influenced by to the presence of the Port of Portland's shipping terminals and Portland International Airport, an area that is now almost exclusively commercial and light industrial. This area has undergone significant recent growth, which is likely to continue in the future. Vacant land available in the Peninsula/Rivergate areas is expected to be developed for commercial use.

The southern portion of the watershed, particularly south of Columbia Boulevard, is mainly residential, with commercial development along the major transportation corridors. The eastern portion of the watershed west of Fairview Lake and Blue Lake was primarily agricultural, but it also has been rapidly converting to commercial and industrial uses in recent years.

The Columbia Slough watershed within the City of Portland is approximately one-third industrial, one-third single-family residential, and one-third mixed development. Although the Slough area will undergo a great deal of redevelopment in the future, the overall division of land uses is not anticipated to change significantly.

Population is projected to grow from 148,054 in 1995 to about 164,000 in 2015 and to about 172,500 in 2040. Significant growth is expected in the central and western areas of the watershed, while other areas should remain relatively stable. The highest growth is expected in recently sewered areas that were part of the city's Mid-Multnomah County Sewerage Project.

SECTION 4. PLAN FORMULATION

4.1 Methodology of Problem Identification. The problems, needs, and opportunities in the study were identified during the General Investigation (GI) feasibility study through meetings with the City of Portland, Bureau of Environmental Services (BES), Multnomah County Drainage District (MCDD), Portland State (PSU), and the US Fish and Wildlife Service. Study efforts were presented and discussed during monthly meetings of the Columbia Slough Watershed Council. The initial GI feasibility study plan emphasized flow augmentation from the Columbia River. When these alternatives did not prove feasible, a meeting with staff from the Corps, BES, MCDD, and PSU identified the additional alternatives which are presented in this report. A Letter of Intent was sent to the Corps by the City of Portland on April 5, 2000, requesting the conversion of the Columbia Slough General Investigation feasibility study to a Section 1135 project. A Preliminary Restoration Plan was submitted by the Portland District for a Section 1135 study on Columbia Slough, and the study was approved for feasibility initiation. The draft Ecosystem Restoration Report and environmental assessment were reviewed by the Corps technical review team and interested Federal, state, and local resource agencies and tribes.

4.2 Alternatives. A total of eight action alternatives were considered in the study. One of these alternatives, the installation of culverts through the main flood control levee at MCDD#4, was dropped from further consideration after initial analyses indicated a cost exceeding $3 million but affecting only 5 acres of habitat. Alternatives are described in the following sections. Their locations are shown on Figure 3a and 3b.

4.2.1 Without Project Conditions. The without project alternative assumed that existing flood protection measures and projects would continue to be operated and maintained. It also assumed projected growth and development in the area would be fully achieved, existing Protection Zones would remain in their current condition, and any legally required mitigation measures and water quality improvement projects would be realized within the planning timeframe. Columbia Slough will remain an ecologically stressed system with fragmented habitat and poor benthic invertebrate species diversity. High levels of macrophytes will continue due to the water level management practices of the Multnomah County Drainage District (MCDD), which are designed to reduce summer algal blooms caused by high nutrient levels.

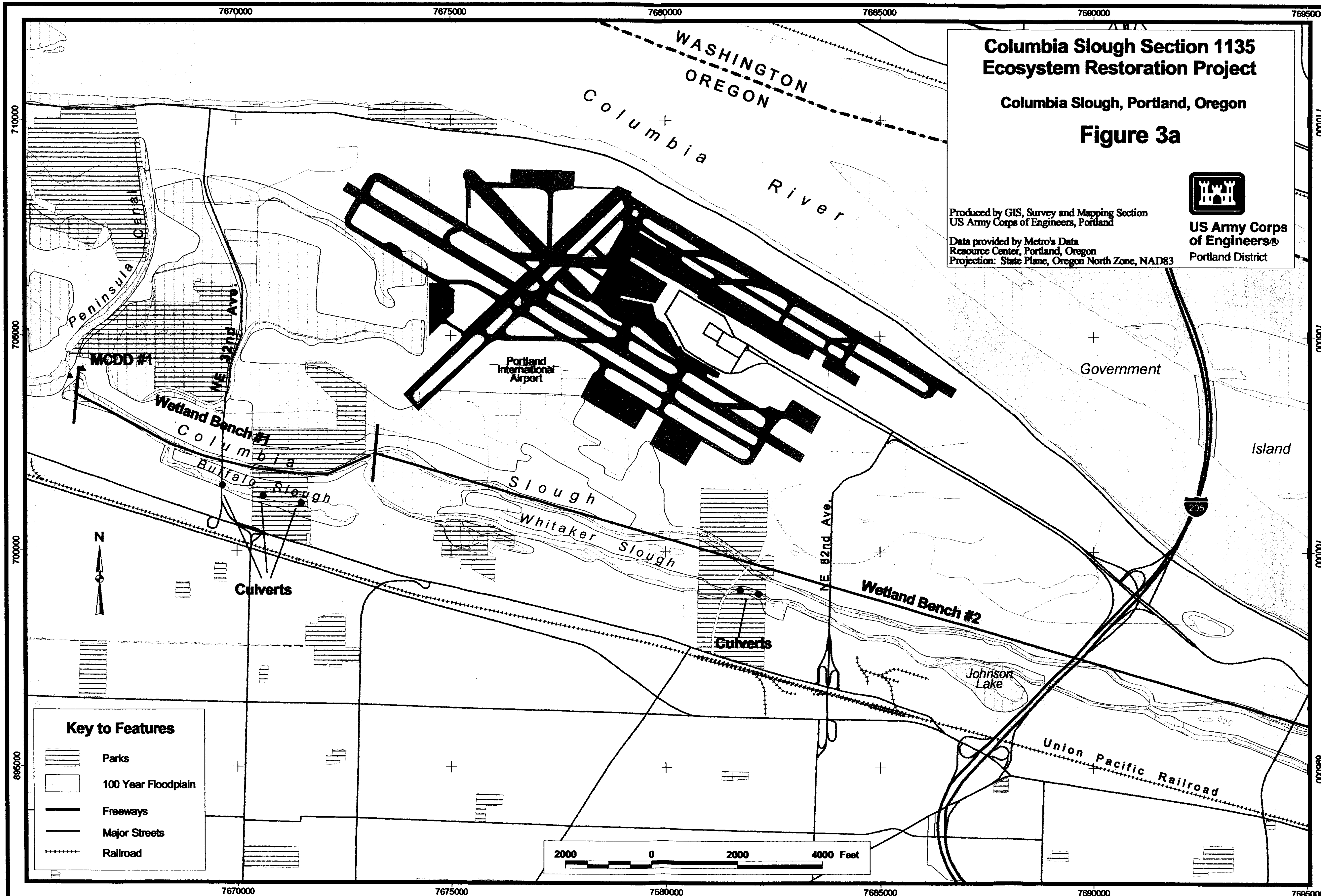
4.2.2 Wetland Benches. - Little emergent marsh habitat is available along the main slough, primarily due to the steep banks and narrow channel along most of the project area. This alternative would involve dredging Columbia Slough from MCDD #1 to NE 158th Avenue (Figures 3a and 3b) to a designed depth and placing the material along the edges of the channel to create wetland benches and a meandering channel during low water summer conditions (Figure 4). The benches would be planted to provide emergent wetland and riparian scrub-shrub wetland vegetation, depending on actual water depth. No real estate costs are associated with this segment, as Multnomah County Drainage District No. 1 has existing flood control maintenance easements which can be used on this project.

4.2 3 Galitzki Springs/Flats. The 19.1-acre site, located east of NE 162nd Avenue between Airport Way to the north and the Union-Pacific Railroad right-of-way to the south (Figure 3b), consists of a 9.4-acre low-lying field (Galitzski Flats; also known as Mason Street wetland) dominated by reed canary grass and a 9.7-acre heavily vegetated sideslope (Galitzki Springs) incised by several small drainages associated with perennial springs. Galitzski Flats was originally a permanent open water body (Duck Lake) that was drained in the early 1920s. Restoration would focus on re-creating wetland and open-water habitat in the Galitzki Flats (Figure 5), and increasing riparian forest cover, improving age-distribution, and snag recruitment in Galitzki Springs. The 9.4-acre Galitzski Flats segment is already owned by the City of Portland. The Galitzski Springs segment is in private ownership.

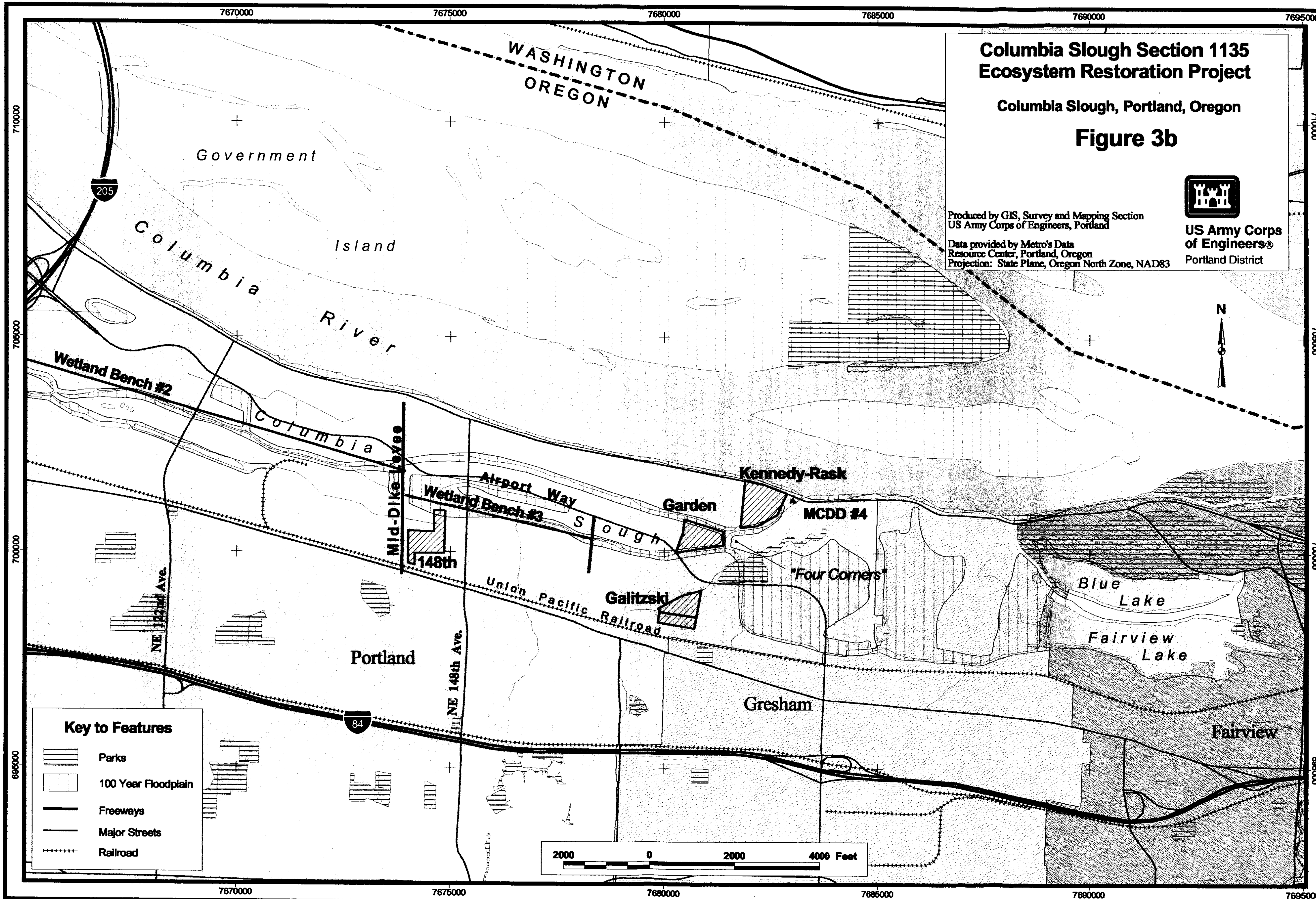
4.2.4 Kennedy/Rask. This 19.7-acre site (Figure 3b) west of MCDD Pump Station #4 includes an open ditch in the west-central portion of the property and an arm of Columbia Slough along the south side. Vegetation consists almost entirely of Himalayan blackberry, with some scattered pockets of black cottonwood, red-osier dogwood, willow, and rose. Restoration would consist of mechanically removing the dense cover of Himalayan blackberry, with the existing cottonwood, willow, rose and dogwood left as undisturbed as possible. Wetland hydrology would be restored to the northern portion by modifying the ditch and associated drainage feature. Native plant species would be planted to re-establish the cottonwood-ash community, and riparian scrub-shrub vegetation would be established in the wettest areas. In addition, a 4-acre section would be planted to provide seasonally wet meadow habitat. This site is in private ownership, and is presently for sale (October 2000).

4.2.5 Gardenburger. The 15.5-acre subject property is located north of Airport Way between NE 162nd and NE 181st Avenues (Figure 3b). Vegetation consists of a mixture of riparian deciduous forest, pine plantation, and dense thickets of Himalayan blackberry. Immediately east of the site is an arm of Columbia Slough, with a contiguous 34-acre stand of cottonwood-ash on the opposite bank. Restoration would entail removing Himalayan blackberry and planting cottonwood-ash forest cover and meadow vegetation. The pine plantation would be thinned to encourage growth of trees and undestory shrubs. Since existing deciduous riparian forest cover is optimal for the management species, it would not require treatment. This site is in private ownership.

4.2.6 NE 148th Avenue Constructed Wetland. Stormwater runoff from 294 acres in the NE 148th Avenue basin (Figure 3b) will reach a constructed wetland through an existing 48-inch storm drain. Runoff will enter a 2.4-acre wet detention pond (forebay) for sediment removal and hazardous material spill containment, then flow into a 3.3-acre constructed wetland marsh. (The 3.3-acre constructed wetland is the alternative considered in this study). Water from the constructed wetland will then flow to an existing wetland and a small pool before entering an existing drainage ditch to Columbia Slough. The constructed wetland will consist of 1.5 acres of low marsh, 1.5 acres of high marsh, and 0.3 acres of semi-wet marsh. Based on the bottom elevation, the vegetation will consist of a combination of submerged and semi-submerged plants and



Columbia Slough Section 1135
Ecosystem Restoration Project
Columbia Slough, Portland, Oregon
Figure 3a
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland
Data provided by Metro's Data
Resource Center, Portland, Oregon
Projection: State Plane, Oregon North Zone, NAD83
US Army Corps
of Engineers®
Portland District
WASHINGTON
OREGON
Columbia River
Peninsula Canal
MCDD #1
NE 32nd Ave.
Wetland Bench #1
Columbia
Buffalo Slough
Slough
Whitaker Slough
Portland International Airport
Government
Island
205
NE 82nd Ave.
Wetland Bench #2
Culverts
Culverts
Johnson Lake
Union Pacific Railroad
N
Key to Features
Parks
100 Year Floodplain
Freeways
Major Streets
Railroad
2000 0 2000 4000 Feet
7670000
7675000
7680000
7685000
7690000
7695000
710000
705000
700000
695000



Columbia Slough Section 1135
Ecosystem Restoration Project
Columbia Slough, Portland, Oregon
Figure 3b
Produced by GIS, Survey and Mapping Section
US Army Corps of Engineers, Portland
Data provided by Metro's Data
Resource Center, Portland, Oregon
Projection: State Plane, Oregon North Zone, NAD83
US Army Corps of Engineers®
Portland District
WASHINGTON
OREGON
Government
Island
Columbia
River
205
Wetland Bench #2
Columbia
Mid-Dike Levee
Airport Way
Wetland Bench #3
Slough
148th
Garden
Kennedy-Rask
MCDD #4
"Four Corners"
Galitzski
Union Pacific Railroad
Blue
Lake
Fairview
Lake
NE 122nd Ave.
NE 148th Ave.
Portland
Gresham
Fairview
84
N
Key to Features
Parks
100 Year Floodplain
Freeways
Major Streets
Railroad
2000
0
2000
4000 Feet
7670000
7675000
7680000
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710000
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695000

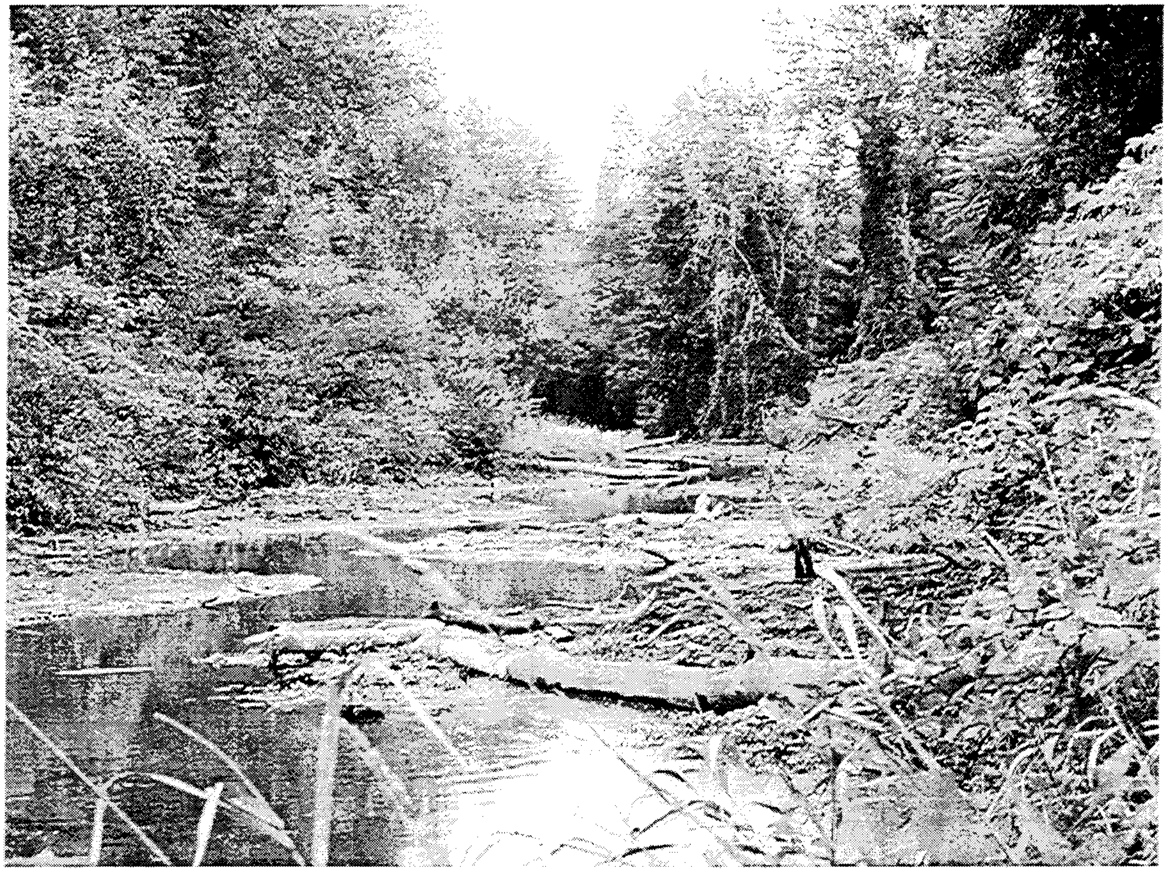

Figure 4. Wetland benches following initial construction, Bridgeton Slough.

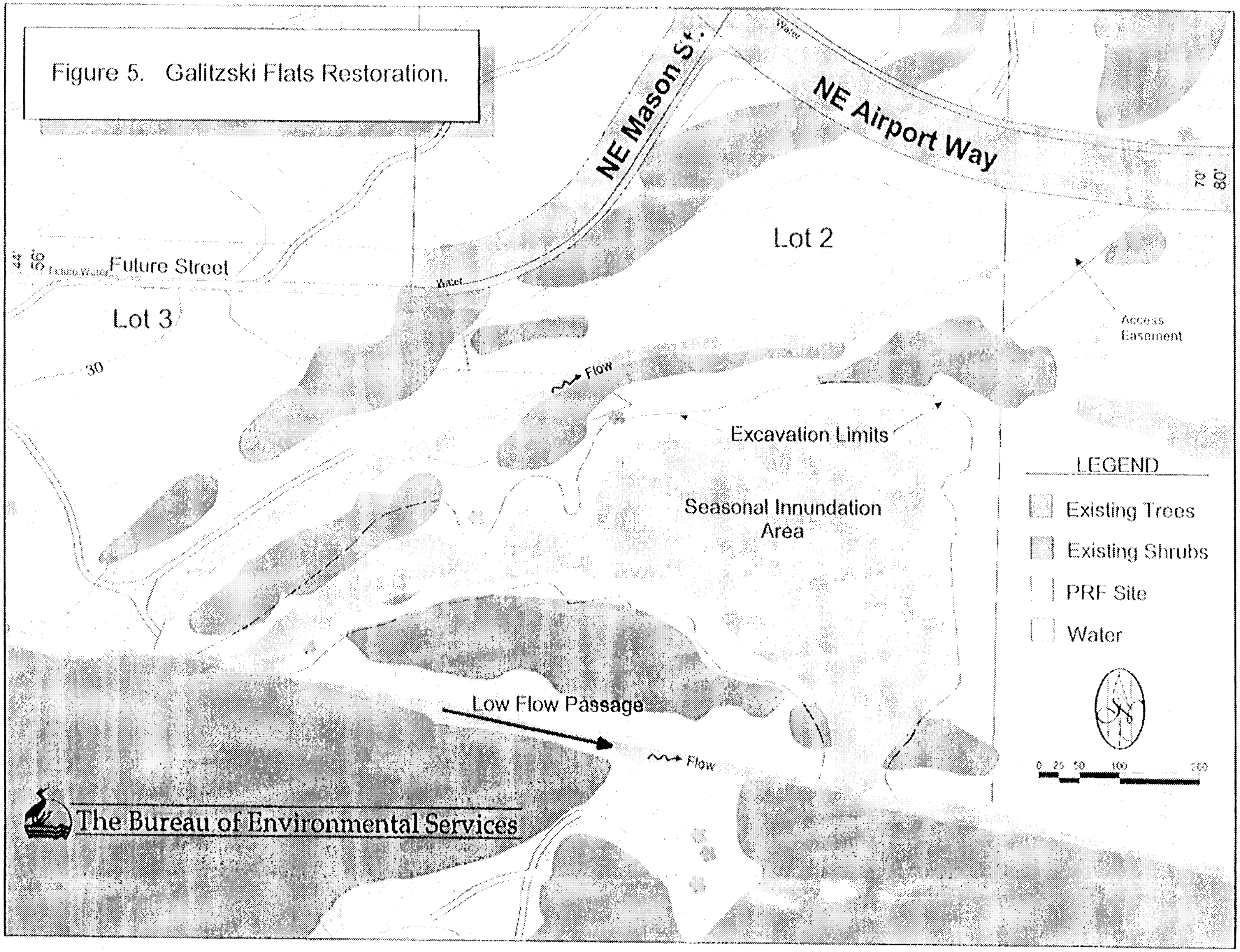

Figure 5. Galitzski Flats Restoration.
NE Mason St.
NE Airport Way
Water
70'
80'
Lot 2
Future Street
Lot 3
30
Flow
Access Easement
Excavation Limits
Seasonal Innundation Area
LEGEND
Existing Trees
Existing Shrubs
PRF Site
Water
Low Flow Passage
Flow
0 25 50 100 200
The Bureau of Environmental Services

vegetation growing in saturated soils. This site has recently been purchased by the City of Portland.

4.2.7 Buffalo Slough Culvert Replacement. Undersized, blocked, deteriorated, and/or high invert elevation culverts are restricting flow in Buffalo Slough and Whitaker Slough (Figure 2a). These flow restrictions increase hydraulic retention time and raise water surface elevations. The stagnant water provides favorable conditions for high water temperatures and severe algal blooms, leading to poor water quality and aesthetics. Culverts will be replaced to decrease water residence time in the slough. Native vegetation will be planted in areas of exposed shoreline to restore wetland vegetation. The primary habitat benefits would be increased benthic invertebrate production and diversity. Each of the culverts would require construction easements.

4.2.8 Whitaker Slough Culvert Replacement. Deteriorated, high invert elevation culverts are also restricting flow in Whitaker Slough (Figure 2a), with similar problems as stated for Buffalo Slough. Culverts will be replaced to decrease water residence time in the slough. Native vegetation will be planted in areas of exposed shoreline to restore wetland vegetation. The primary habitat benefits would be increased benthic invertebrate production and diversity. Both of the culverts would require an easement. The combined effects of replacing the culverts and managing water levels in the main slough will require that the water supply intake for Colwood Golf Course be replaced with a well. This item, with an estimated project cost of $162,000, would be a responsibility of the local sponsor (City of Portland) to replace, but they would receive credit on their cost share. (This item was determined to be needed after completion of the cost-effectiveness analysis, and was not included in the cost estimate for Whitaker Slough culverts. However, this alternative proved to be the most cost-effective of all the alternatives, by a significant margin. Even with the cost of the well included, this result would not change.)

4.2.9 Culverts through Flood Control Levee at MCDD #4. In order to improve dissolved oxygen concentrations in the upper slough, this alternative consists of constructing two 48-in gated culverts through the flood control levee adjacent to MCDD Pump #4 (Figure 2b). This would allow the transfer of water between the Columbia River and the upper slough by gravity flow. The structure would include fish screens, sized so criteria would be met for salmonid fry. Initial investigations of this alternative indicated that there would be an initial cost of $3.2 million, with a maximum of 5 acres that would benefit from the alternative. There would also be high maintenance costs for MCDD for the fish screens, due to the presence of algae and macrophytes in the slough system. After discussions with the City of Portland and MCDD, this alternative was not considered feasible and further study was eliminated.

4.3 Evaluation of Management Measures. The seven action alternatives were evaluated in more detail. Each of the alternatives met all engineering and technical criteria. They also met, to varying degrees, the environmental and social criteria and project goals. Evaluation and selection of a final restoration plan are based on several additional criteria. These criteria include the significance of the resource and project area, local sponsor input and support, reasonableness of project cost, cost-sharing policies, and a cost-effectiveness analysis and an incremental cost evaluation analysis (CEA/ICA).

Since the benefits of restoration projects are not typically measured in monetary terms, a benefit-to-cost ratio is not used to determine project justification, and maximizing net benefits can not be used to optimize project outputs. Cost effectiveness and incremental analysis are tools that can be used to evaluate contributions of various plans when benefits are not identified in monetary terms, but rather in environmental outputs. The

Table 4.1. Buffalo Slough Culverts

Location	Diameter	Length	Invert Elevation East end	Invert Elevation West end	Style	Comments
	in	ft	ft MSL			
Buffalo Slough (W to E)						
NE 33rd Ave.	48	122	5.89	5.12	CMP	Corrosion possible; high invert; capacity
Broadmoor W	48	40	4.92	5.07	CMP	Corrosion; pipe split
Broadmoor E	36	56	6.30	5.78	CMP	Corrosion; high invert; capacity

Notes:
CMP = Corrugated metal pipe
CSP = Concrete sewer pipe

Table 4.2. Whitaker Slough Culverts

Location	Diameter	Length	Invert Elevation East end	Invert Elevation West end	Style	Comments
	in	ft	ft MSL			
Whitaker Slough (W to E)						
Colwood W	48	38	6.13	6.34	CSP	Pipe separated; high invert
Colwood E	48	42	5.63	6.17	CSP	Pipe separated; high invert

Notes:
CMP = Corrugated metal pipe
CSP = Concrete sewer pipe

cost effectiveness portion of the evaluation ensures that least cost alternatives are identified for various levels of environmental output. These are referred to as "efficient alternatives". The subsequent incremental evaluation evaluates changes in costs for increasing levels of environmental output. The results of an incremental evaluation do not result in a discrete decision criteria (such as the plan that maximizes net benefits), but provides a tool to facilitate plan selection.

To complete the cost effectiveness and incremental evaluation quantification of the environmental quality, outputs and conceptual level designs and costs for each plan are required. Section 4.4 outlines the methodology that has been used to quantify environmental outputs. This is followed by a description of project costs in Section 4.5, and the results of the cost effectiveness and incremental evaluation in Section 4.6.

4.4 Restoration Benefits

The feasibility study focuses on translating potential water quality benefits resulting from flow management measures and other ecosystem restoration opportunities into biological outputs. A modification of the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP) was used to assess existing wildlife values and to model the potential benefits of proposed actions. Briefly, HEP is based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). HSI models primarily focus on the measurement of physical habitat variables that are strongly correlated with habitat quality for a given species. The HSI is a rating (0.0 to 1.0) of the suitability of the habitat for a particular species when compared to optimum habitat conditions for the species. The index is multiplied by the area of available habitat to obtain "habitat units" (HUs) for a given species. The total number of habitat units for each species and each alternative is divided by the life of the project to calculate the average annual habitat units (AAHUs).

Four species (yellow warbler, downy woodpecker, black-capped chickadee, and Townsend's vole) and one species assemblage (benthic macroinvertebrates) were chosen to quantify the changes in habitat values that are anticipated to occur with the proposed projects (Table 4.3). These indicators were selected for the following reasons:

- The vertebrate species are of local, state, and/or Federal interest.
- The vertebrate species are closely associated with rare or declining natural communities that have been negatively affected by Corps of Engineers projects.
- Benthic invertebrates are a critical link in aquatic food chains.
- Species composition of benthic communities is a good indicator of water quality.
- HSI models exist or can be easily modified to measure habitat conditions.
- Habitat can be easily measured and monitored.

The yellow warbler is a neotropical migrant that has been identified as a species of management concern by Partners in Flight. Yellow warbler habitat consists of wet areas with abundant shrubs or small trees. The species was selected due to its conservation status and its preference for scrub-shrub wetlands, a vegetation type that has been severely impacted in the project area. The yellow warbler is an appropriate species for habitat restoration projects in urban areas due to its ability to nest successfully in residential areas and relatively small nesting area requirements (approximately 0.3 acre).

The downy woodpecker and black-capped chickadee are insectivorous forest dwellers. These species were selected to represent forested habitats. Tree density, or basal area, is an important factor for downy woodpeckers, as they forage primarily along bark surfaces. Downy woodpeckers were selected to represent habitat conditions in mixed hardwood/ conifer stands. The canopy volume of trees is a more important habitat characteristic for black-capped chickadees than is basal area. Black-capped chickadees are commonly associated with deciduous forest in Oregon and were selected in this study to represent habitat conditions in cottonwood-willow communities. The availability of snags for nesting is an important factor for both downy woodpeckers and black-capped chickadees.

Table 4.3. Cover types and associated species used in habitat evaluations.

Cover Type	Yellow Warbler	Downy Wood-Pecker	Black-Capper Chickadee	Townsend's Vole	Benthic Inverte-Brates
Riparian scrub-shrub	FR				
Cottonwood/Ash			FR		
Emergent Wetland					FR
Aquatic bottom					FR
Mixed Hardwood/Conifer		FR			
Conifer (plantation)		FR			
Meadow				FR	

F = foraging,
R = reproduction

snags for nesting is an important factor for both downy woodpeckers and black-capped chickadees.

Voles and other microtines that use meadow environments provide an important food source for hawks, owls, snakes, and other predatory animals. Meadows also provide insect prey for bats, swallows, and purple martins. Meadows may also provide nesting areas for painted turtles when located near (i.e., within 500 feet) suitable aquatic habitat.

The abundance and diversity of benthic invertebrates was selected to indicate predicted improvements in all permanently flooded areas (i.e., emergent wetlands and aquatic bottom habitats). Macroinvertebrates serve various functions in aquatic ecosystems, particularly as secondary consumers in many food chains and as recyclers of organic matter. They also are important organisms in the diet of many species of wildlife and fish. Benthic invertebrates play a critical role in the diet of young painted turtles and breeding female ducks. The diversity of benthic invertebrates was selected to indicate predicted improvements in the benthos, including all areas permanently or seasonally flooded.

Increases in habitat units for each species were weighted equally in the analysis. Habitat units were estimated at fully developed levels. Table 4.4 summarizes the total increase in habitat units for each of the action alternatives, as well as the annualized average habitat units (AAHU). The AAHU were used in the cost effectiveness and incremental analyses.

4.5 Cost of Each Measure. Preliminary costs were developed for each conceptual alternative and are summarized below (Table 4.5). Real estate costs are gross estimates. It was assumed that real property acquisitions would not alter current zoning on lands adjacent to the proposed alternatives; cost estimates took into account existing environmental and preservation zoning. Planting and construction costs include engineering and design, construction management, and contingency costs.

Table 4.4. Environmental Outputs

		Habitat Units			
Alternatives	**Acres**	**Existing**	**With Alternative**	**New**	**AAHU***
148th Ave. Wetland	3.3	0.0	3.3	3.3	3.1
Gardenburger	15.5	10.1	14.9	4.8	4.1
Buffalo Slough Culverts	16.7	1.1	7.4	6.3	6.1
Galitzki Spring & Flats	19.1	6.7	17.3	10.6	9.7
Wetland Bench	36.5	4.1	18.1	14.0	13.5
Whitaker Slough Culverts	51.7	4.3	18.4	14.1	13.6
Kennedy-Rask	19.7	0.0	16.8	16.8	14.1
TOTAL	162.5	26.3	96.2	69.9	64.2

* Annualized Average Habitat Units

4.6 Cost Effectiveness and Incremental Cost Evaluation

Each of the seven improvements evaluated in this study could be implemented alone, or in combination with the other improvements. These alternatives are considered individually and in combination in the cost-effective and incremental cost analyses. The average annual habitat units listed represent the net increase in output above and beyond the without project condition.

The costs of implementation for the project include all costs associated with the project, such as development costs, real estate costs, and operation and maintenance costs. The project costs are expressed in terms of average annual dollars per average annual environmental output.

Table 4.6 summarizes the net gains in average annual environmental outputs, the average annual costs, and the average annual cost per environmental output for each alternative site.

Table 4.7 displays the cost-effective least-cost sites and/or combinations of sites, listed in ascending order of average annual environmental outputs. Sites (or combinations of sites) that had a higher cost for a given level of environmental outputs were not cost-effective, and were dropped from further consideration.

Table 4.8 summarizes the results of the final incremental cost analysis. Incremental cost analysis is required to address whether the incremental or additional cost of the next level of output is worth it. In environmental studies, the comparison is between dollar incremental costs and non-dollar incremental units of output. The column on the right summarizes the incremental average annual cost per output, identifying potential breakpoints where the next level of output shows a marked increase in costs. For instance, there is a significant breakpoint in incremental average annual cost per output between the combination including Whitaker, Wetland Benches, Kennedy, Buffalo, and Galitzski sites and the next combination, which adds NE 148th Avenue to the previous group. The incremental average annual cost per output is nearly triple that for the previous combination.

Based on the results of the cost effectiveness and incremental costs analyses, the combination including Whitaker, Wetland Benches, Kennedy, Buffalo, and Galitzski sites, looks like the best investment. However, it should be noted that cost effectiveness and incremental cost analyses alone do not result in a unique plan recommendation.

Table 4.5. Preliminary Cost Summary of Alternatives

Alternatives	Real Estate Cost ($1,000)	Planting & Construction Costs(1) ($1,000)	Subtotal Initial Cost ($1,000)	IDC(2) ($1,000)	Total Project Cost ($1,000)	Average Annual Cost (3) ($)
NE 148th Ave.Wetland	742.5	399.3	1141.8	37.4	1179.2	$ 82,594
Gardenburger	1500	121.3	1621.3	53.1	1674.4	$116,104
Buffalo Slough Culverts	*7.5*	*618.5*	*626.0*	20.5	646.5	$ 44,637
Galitzski Flats / Springs	*505*	*829.0*	*1334.0*	43.7	1377.7	$ 96,964
Wetland Benches	*0*	*777.3*	*777.3*	25.5	802.8	$ 55,429
Whitaker Slough Culverts	*5*	*172.1*	*177.1*	5.8	182.9	$ 12,629
Kennedy-Rask	*1150*	*243.4*	*1393.4*	45.7	1439.1	$100,301

(1) Includes design, construction management,and contingency costs
(2) Interest During Construction
(3) Includes estimated operation and maintenance costs

Table 4.6. Average Annual Environmental Outputs, Average Annual Costs, and Average Annual Cost Per Environmental Output				
Alternatives	**Symbol**	**Ave. Ann. Output**	**Ave. Ann. Cost**	**Ave. Ann. Cost per Output**
Base Condition	Base	0	$ -	$ -
NE 148th Ave. Wetland	148	3.1	$ 82,594	$ 26,643
Gardenburger	Gard	4.1	$116,104	$ 28,318
Buffalo Slough Culverts	Buff	6.1	$ 44,637	$ 7,318
Galitzski Flats / Springs	Gal	9.7	$ 96,964	$ 9,996
Wetland Benches	Wet	13.5	$ 55,429	$ 4,106
Whitaker Slough Culverts	Whit	13.6	$ 12,629	$ 929
Kennedy Rask	Kenn	14.1	$100,301	$ 7,114

Table 4.7. Cost-Effective Least-Cost Combinations, Average Annual Environmental Outputs and Average Annual Cost		
Alternatives	**Ave. Ann. Output**	**Ave. Ann. Cost**
Base	0.0	$ -
Whit	13.6	$ 12,629
Whit-Buff	19.7	$ 57,266
Whit-Wet	27.1	$ 68,058
Whit-Buff-Wet	33.2	$112,695
Whit-Buff-Kenn	33.8	$157,567
Whit-Wet-Gal	36.8	$165,022
Whit-Wet-Kenn	41.2	$168,359
Whit-Buff-Wet-Gal	42.9	$209,659
Whit-Buff-Wet-Kenn	47.3	$212,996
Whit-Wet-Kenn-Gal	50.9	$265,323
Whit-Buff-Wet-Kenn-Gal	57.0	$309,960
Whit-Buff-Wet-Kenn-Gal-148	60.1	$392,554
Whit-Buff-Wet-Kenn-Gal-Gard	61.1	$426,064
Whit-Buff-Wet-Kenn-Gal-148-Gard	64.2	$508,658

Table 4.8. Summary of Final Incremental Cost Analysis					
Alternatives	Total Ave. Annual Cost	Total Ave. Annual Output	Added Ave. Annual Output	Added Ave. Annual Cost	Incremental Ave.Ann. Cost / Ave.Ann. Output
Base	$ -	0.0	0	$ -	$ -
Whit	$ 12,629	13.6	13.6	$ 12,629	$ 929
Whit-Wet	$ 68,058	27.1	13.5	$ 55,429	$ 4,106
Whit-Wet-Kenn	$168,359	41.2	14.1	$100,301	$ 7,114
Whit-Wet-Kenn-Buff	$212,996	47.3	6.1	$ 44,637	$ 7,318
Whit-Wet-Kenn-Buff-Gal	$309,960	57.0	9.7	$ 96,964	$ 9,996
Whit-Wet-Kenn-Buff-Gal-148	$392,554	60.1	3.1	$ 82,594	$ 26,643
Whit-Buff-Wet-Kenn-Gal-148-Gard	$508,658	64.2	4.1	$116,104	$ 28,318

4.7 Justification and Selection of Final Plan. Cost-sharing policies also affect the decision on the recommended plan. The local sponsor's cost share for a Section 1135 project is 25%. The local sponsor is also required to obtain all lands, easements, rights-of-way, utility or public facility relocations, and dredged or excavated material disposal areas (LERRD) required for the implementation, operation and maintenance of the project. The City of Portland wants to include the Galitzski alternative in the recommended plan, as they already own the 9-acre Galitzski Flats site, about half of the real estate for the Galitzski alternative. Inclusion of Kennedy-Rask would include an additional $1.1 million cost in real estate acquisition for the city. Although the Kennedy-Rask site has reasonable environmental outputs, it is not included in the final plan recommended for implementation because of the relatively high financial cost to the City, and because over 80 percent of the cost of this alternative is real estate. The resulting plan includes culvert replacements at Whitaker and Buffalo Sloughs, wetland benches along the main Columbia Slough, and restoration at Galitzski Springs /Flats.

SECTION 5. RECOMMENDED PLAN

5.1 Description of the Recommended Plan. The proposed project will consist of three main components: (1)creation of wetland benches and a meandering channel by dredging the Columbia Slough between MCDD Pump Station No. 1 (MCDD #1) and NE 158th Avenue to a designed depth, then placing the material along opposite sides of the channel to create wetland benches; (2) replacing three culverts in Buffalo Slough and two culverts in Whitaker Slough; and (3) constructing a wetland marsh covering nine acres at Galitzski Flats near 162nd Avenue, and restoring nine acres of adjacent riparian woodland habitat at Galitzski Springs by removing invasive species and planting native species.

5.2 Design Features

5.2.1 Wetland Benches. The wetland benches will be planted to provide emergent wetland and riparian scrub-shrub wetland vegetation, depending on actual water depth. In addition to wetland creation, channel bank vegetation would be restored by removing Himalayan blackberry and other non-native plants that inhibit native vegetation and then planting riparian trees and shrubs.

The assessment area (Figures 3a and 3b) includes the main Columbia Slough from NE 158th Avenue downstream 7.6 miles to the levee at the Peninsula Drainage Canal at NE 17th Avenue (MCDD Pump Station #1). Although the slough extends upstream of NE 158th Avenue to Fairview Lake, the proposed action would not affect this reach.

The ecological goal for constructing wetland benches in Columbia Slough is to increase channel habitat complexity while providing a hydrologic period that more closely mimics off-channel sloughs with direct connection to the Columbia River. Ecosystem restoration criteria include restoring riparian scrub-shrub, emergent wetland and aquatic bottom habitat to optimal condition for yellow warbler and benthic invertebrates.

The proposed action would create or enhance three habitat types: riparian scrub-shrub, emergent wetland, and aquatic bottom. These habitat types correspond with Cowardin's classification of palustrine systems (Cowardin et al. 1979). In the main Columbia Slough, riparian scrub-shrub occurs above the summer low water elevation, which is 5.5 feet in the middle slough and 8.5 feet in the upper slough. Emergent wetland occurs in the zone between riparian scrub-shrub and approximately 3 feet below the mean summer water elevation. Aquatic bottom habitat is permanently flooded and occurs more than 3 feet below the low summer water elevation, which is generally the maximum depth at which emergent plants can grow. Additional aquatic bottom habitat is created by this alternative when the dredging increases the channel bottom area where water depths exceed 3 feet during the summer low water elevation.

An estimated total of 44,900 cubic yards of material would be excavated from the channel bottom and placed within the channel. There would be three segments where the wetland benches would be created.

- *MCDD Pump Station (PS) #1 to the mouth of Whitaker Slough:* This reach, extending about 1.3 miles, would have 13,050 cubic yards of material dredged from the channel bottom. Columbia Slough is relatively wide in this segment, with channel bottom widths of 60 – 80 feet. Material would be dredged in two passes near each side of the channel, with the dredged material placed in the center of the channel to create an island (Figure 6). After planting with the appropriate vegetation, this would create 1.4 acres of emergent wetland and 1.0 acre of riparian scrub-shrub habitat. Deepening the channel will also result in an increase of 0.6 acres of aquatic bottom habitat.
- *Mouth of Whitaker Slough to mid-dike levee:* This reach, extending about 5.4 miles, would have 26,250 cubic yards of material dredged from the channel bottom and placed on alternating sides of the channel (Figure 7). The channel bottom is typically 20 – 45 feet wide in the reach, and channel banks are typically steep and covered with Himalayan blackberry. After planting, about 8.3 acres of emergent wetland and 1.0 acre of additional aquatic bottom habitat would be created.
- *Mid-dike levee to NE 158th Avenue:* This reach, extending about 0.8 miles, would have 5,600 cubic yards of material dredged from the channel bottom and placed on alternating sides of the channel. Channel bottom widths vary between 18 – 62 feet. After planting, about 1.6 acres of emergent wetland and 0.1 acre of additional aquatic bottom habitat will be created.

Immediately upstream of the last reach, bedrock is near the channel bottom until the "Four Corners" segment is reached, where an arm of Columbia Slough branches off to MCDD Pump Station #4 next to the main flood control levee. There are preservation and conservation zones, as well as wetland mitigation areas, upstream of the Four Corners area to the outlet of Fairview Lake. Creation of additional wetland benches is not warranted in this reach.

5.2.1.1 Water Level Management. Water levels in Columbia Slough are managed with a system of levees, dikes, slide gates and pumps. Key issues for development and maintenance of wetland vegetation in the slough include seasonal water depth and the timing, duration and frequency of drawdowns. The speed of drawdowns strongly effects the kinds and variety of vegetation cover that an area will support. A slow drawdown taking 4 to 6 weeks to complete usually produces a more diverse vegetative cover than a fast drawdown taking only a few days. Timing of drawdown also effects vegetation diversity. Maintaining high water levels (>18") through June has been shown to suppress reed canary grass.

Currently, normal pool elevation in Columbia Slough is maintained at 5.5 feet in the middle slough and 8.0 feet in the upper slough throughout the year. The higher water elevations in the upper slough are necessary for irrigation and wetland maintenance. Although water elevations usually rise during heavy storm events, pumping returns water elevations to normal pool within 3 days. Water levels in the middle slough can be allowed to drop below 5.5 feet but only when the Columbia River falls below elevation 4.5 feet.

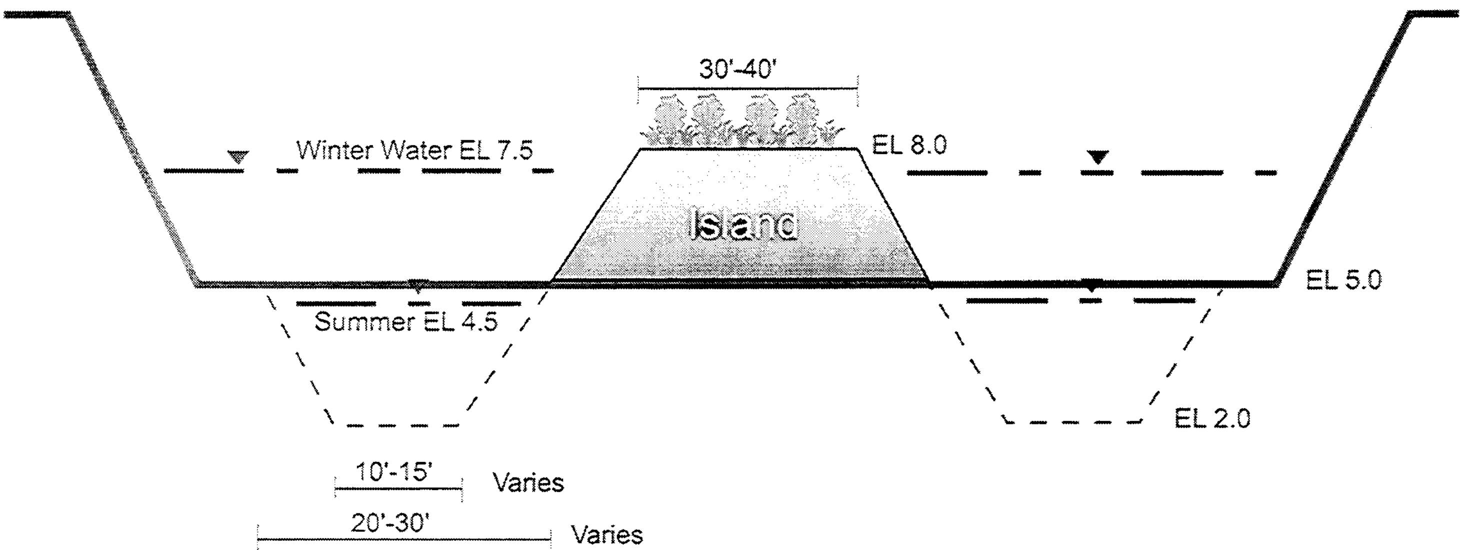

Figure 6. Middle Slough Island Design & Trench

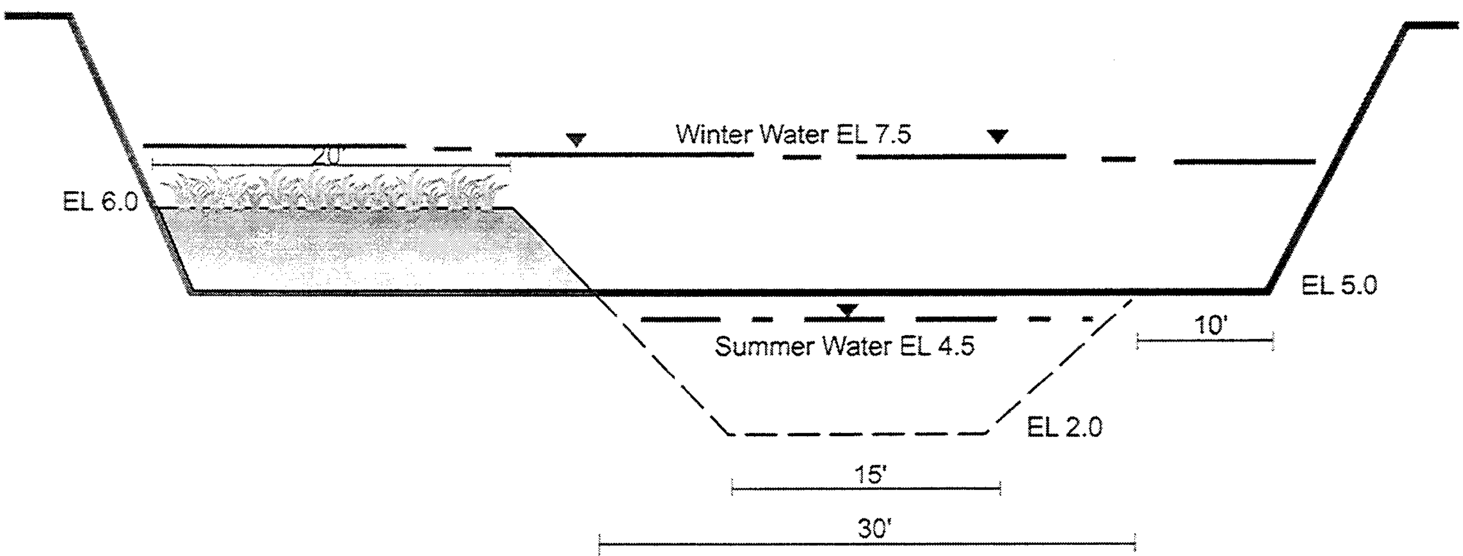

Figure 7. Middle Slough Bench & Trench Design

Not to Scale

Table 5.1. Number of acres HUs, and design water elevations for wetland benches.

REACH Habitat Type	DESIGN ELEV.[1]	ACRES		NEW HUs
		Existing	With project	
PS#1 TO WHITAKER SLOUGH				
Riparian scrub-shrub	5.0-6.5	0.0	1.0	1.0
Emergent wetland	2.0-5.0	0.0	1.4	1.4
Aquatic bottom*	<2.0	8.1	5.5	0.6
Total		8.1	7.9	3.0
WHITAKER SLOUGH TO MID-DIKE				
Riparian scrub-shrub	5.5-7.0	0.0	0.0	0.0
Emergent wetland	2.5-5.5	2.2	9.1	8.3
Aquatic bottom*	<2.5	20.6	15.1	1.0
Total		22.8	24.2	9.3
MID-DIKE TO 158th Avenue				
Riparian scrub-shrub	8.5-10	0.0	0.0	0.0
Emergent wetland	5.5-8.5	1.6	2.2	1.6
Aquatic bottom*	<5.5	2.8	2.2	0.1
Total		4.4	4.4	1.7
PS#1 TO 158th Avenue				
Riparian scrub-shrub		0.0	1.0	1.0
Emergent wetland		3.8	12.7	11.3
Aquatic bottom*		31.5	22.8	1.7
Total		**35.3**	**36.5**	**14.0**

* Increase in aquatic bottom habitat is due to increase in area where water depths exceed 3 feet.

Minimum pool elevations throughout the year provide very little opportunity to mimic the gradual drawdown of off-channel sloughs that typically would occur if the slough had a direct connection to the Columbia River. Ideally, drawdown would commence in late-May or early-June and take a minimum of 4 weeks to complete. This regime would provide more diverse riparian vegetation than a rapid drawdown. One alternative to current management would be to hold water levels above mean pool elevation in late-winter through early-spring, begin slowly drawing down in May, and attain minimum pool by about mid-June. Drawdown would be delayed to late-June in some years to suppress reed canary grass. This scenario may have short-term negative effects to certain water quality parameters but these impacts may be offset by improved development of wetland vegetation.

5.2.1.2 Vegetation Plantings. Winter water levels are less of a concern for riparian plant development than are summer levels. Emergent plants are particularly sensitive to water depth. Even short-term flooding of 2 to 3 feet will severely limit emergent plant distribution. Emergent vegetation cannot survive even short-term exposure. As long as the ideal water depth for marsh emergents (1-2 feet) is continually shifting within an impoundment, their success will be limited. Predicting water levels in the slough to within inches is problematic due to the effects of macrophytes on flow. It is recommended that water levels be measured at the wetland benches before planting any species of emergent vegetation that are highly sensitive to fluctuating water levels. The benches should be seeded with native graminoids at the predicted summer low water level to control soil erosion.

Riparian shrubs should dominate wetland bench vegetation at elevations above the mean low water level. Habitat for yellow warbler includes a dense (>70%) deciduous shrub canopy with average height ≥6.5 feet. Shading exceeding 80% has been shown to suppress reed canary grass biomass. Riparian shrubs such as willows, spiraea, and red-osier dogwood are hydrophytic shrubs, which can withstand flooding and perform well in environments with fluctuating water levels. The benches should be densely planted with shrub seedlings to accelerate establishment of a robust riparian zone that will control reed canary grass. Drawdown should begin no later than mid-July to provide an adequate growing period for native shrub vegetation.

5.2.2 Buffalo Slough and Whitaker Slough Culverts

Various modeling runs conducted for the Whitaker Slough (Berger and Wells, 1997, 1999) indicate that west of the NE 78th Court no changes in the channel bottom but only changes in culvert invert elevation are required to achieve improved water quality.

Culvert invert elevations and diameter were selected using the following criteria:

- Invert elevation to be a minimum of ½ foot below the minimum summer low flow elevation. This will provide sufficient capacity to prevent water backup upstream of the culvert.
- The top of the culvert would be above the maximum summer water elevation. This will allow free passage of floating organic material (algae, duckweed) and debris.

Assuming a minimum summer low flow water level elevation of about 4.5 feet along Buffalo Slough and about 5 feet in Whitaker Slough near NE 78th Court, the maximum invert elevation would be about 4.5 feet at the east end of the study area and about 4 feet at the west end (Table 5.2). These assumptions are based on long-term observations of water levels in the Willamette River and limitations of the pumps at the MCDD#1. Most likely, the summer low flow water level elevations will be higher for the following reasons:

- Hydrophytic vegetation on wetland benches and berms in the main Slough will require regular inundation or saturation for some time during the growing season.
- Macrophyte growth in the low flow channel will create a steeper water level elevation gradient, resulting in increasing water level elevations upstream of MCDD#1.

Table 5.2. Summary of Culvert Replacement Recommendations

Location	Diam.(in.) Exist/New	Length ft	Invert Elevation east end (ft MSL)	Invert Elevation west end (ft MSL)	Style
Buffalo Slough (W to E)					
NE 33rd Ave.	- / 48	120	4.0	4.0	HDPE
Broadmoor W	48 / 48	60	4.0	4.0	CSP or HDPE
Broadmoor E	48 / 48	48	4.0	4.0	CSP or HDPE
Whitaker Slough (W to E)					
Colwood W	48 / 72	36	4.5	4.5	CSP or HDPE
Colwood E	48 / 72	36	4.5	4.5	CSP or HDPE

The two culverts at Colwood Golf Course and two culverts at Broadmoor Golf Course are located on golf cart crossings. Construction of these four culverts will use standard excavation techniques to remove the existing culverts and replace them.

The culvert at NE 33rd Avenue will require special construction techniques. NE 33rd Avenue is a 4-lane road and a major connecting road between Marine Drive and Columbia Boulevard. Groundwater levels are also quite high in the area, and would make the use of conventional trenching methods very costly. Consequently, it is recommended that a boring machine be used, and that the existing culvert left in place. The new culvert would be placed to the north of the existing culvert.

5.2.3 Galitski Spings and Flats

5.2.3.1 Galitzski Flats. Currently, a 54-inch-diameter storm sewer pipe drains a 420-acre basin and discharges to an open ditch north of NE Sandy Boulevard and eventually into the Columbia Slough. Recently, the stormwater has been diverted to a wet sedimentation pond built along NE Sandy Boulevard between NE 158th Avenue and 162nd Avenue, prior to discharging into the open ditch. This treated wastewater will then be routed to the proposed constructed wetland on Galitzski Flats. The existing wetland, a reed canarygrass monoculture, will be recontoured and enhanced by planting a variety of native vegetation to provide habitat for a variety of species. The treated stormwater will be used to provide the water necessary to create a diverse wetland.

The constructed wetland will consist of a combination of the following design elements:

- 0.3 acres of deep-water habitat with a bottom elevation more than 18 inches below the normal water surface elevation.

- 1.5 acres of low marsh with a bottom elevation about 6 to 18 inches below the normal water surface elevation.
- 2.0 acres of high marsh with a bottom elevation about 1 to 6 inches below the normal water surface elevation.
- 0.2 acres of semi-wet marsh with a bottom elevation about zero to 24 inches above the normal water surface elevation.

The wetland will be allowed to dry out during summer, with the exception of the deep-water habitat, to mimic natural conditions of wetlands in this watershed.

5.2.3.2 Galitzski Springs. The site consists of gently sloping (2 to 8 percent) terrain incised by several small drainages associated with perennial springs (Figure 8). Water from the hillside springs and seeps drains into a ditch at the bottom of the slope, which carries the flow northeast into the Columbia Slough. Vegetation on the property consists of a mosaic of deciduous forest and shrub thicket, punctuated by occasional openings associated with past disturbance. Several large Western redcedar and big-leaf maple trees occur on the better drained soils of the upper slope. Dominant tree species along the lower slopes include red alder, Oregon ash, and black cottonwood. A narrow band of riparian scrub-shrub vegetation at the base of the slope consists of Scouler's willow, red-osier dogwood, red elderberry, beaked hazelnut, Douglas' hawthorn, clustered and Nootka rose, and snowberry. Himalayan blackberry occurs throughout the property and forms several large (1- to 2-acre) patches.

The subject parcel, with its perennial springs, terrace and slope topography, and varying soil types, offers unique restoration opportunities. The juxtaposition of the forested slope and adjacent wet meadow and emergent wetlands makes this one of the most valuable restoration sites in the project area. The dominant vegetation is forest: cottonwood/ash on the lower slope and mixed hardwood/conifer on the upper terrace. Historic logging operations reduced tree cover, particularly conifers, and the invasion of Himalayan blackberry into disturbed areas prevented natural reforestation. The lack of snags and downed woody debris is clearly evident today. Restoration would focus on increasing forest cover, improving age-distribution, and snag recruitment. This would be accomplished primarily through invasive plant control and revegetation efforts. Restoration would result in an increase in habitat suitability in the three cover types. Recruitment of large snags would require several decades. Existing redcedars and mature maple, alders, and cottonwoods will provide snag habitat within the next 10 to 20 years.

5.3 Real Estate. The Columbia Slough Section 1135 Project involves approximately 19.1 acres of land for initial construction. For construction of the wetland benches, it will require the use existing flood control easements held by MCDD No. 1 for 7.5 miles of the main slough (creating approximately 11.3 acres of new emergent wetland), as well as flood control and construction easements for the five culverts at Buffalo and Whitaker Sloughs. It will require the purchase of 9 acres (Galitzski Springs). The 9 acres at Galitzski Flats have already been purchased by the City of Portland. A new well would be required at Colwood Golf Course due to lowering of water levels.

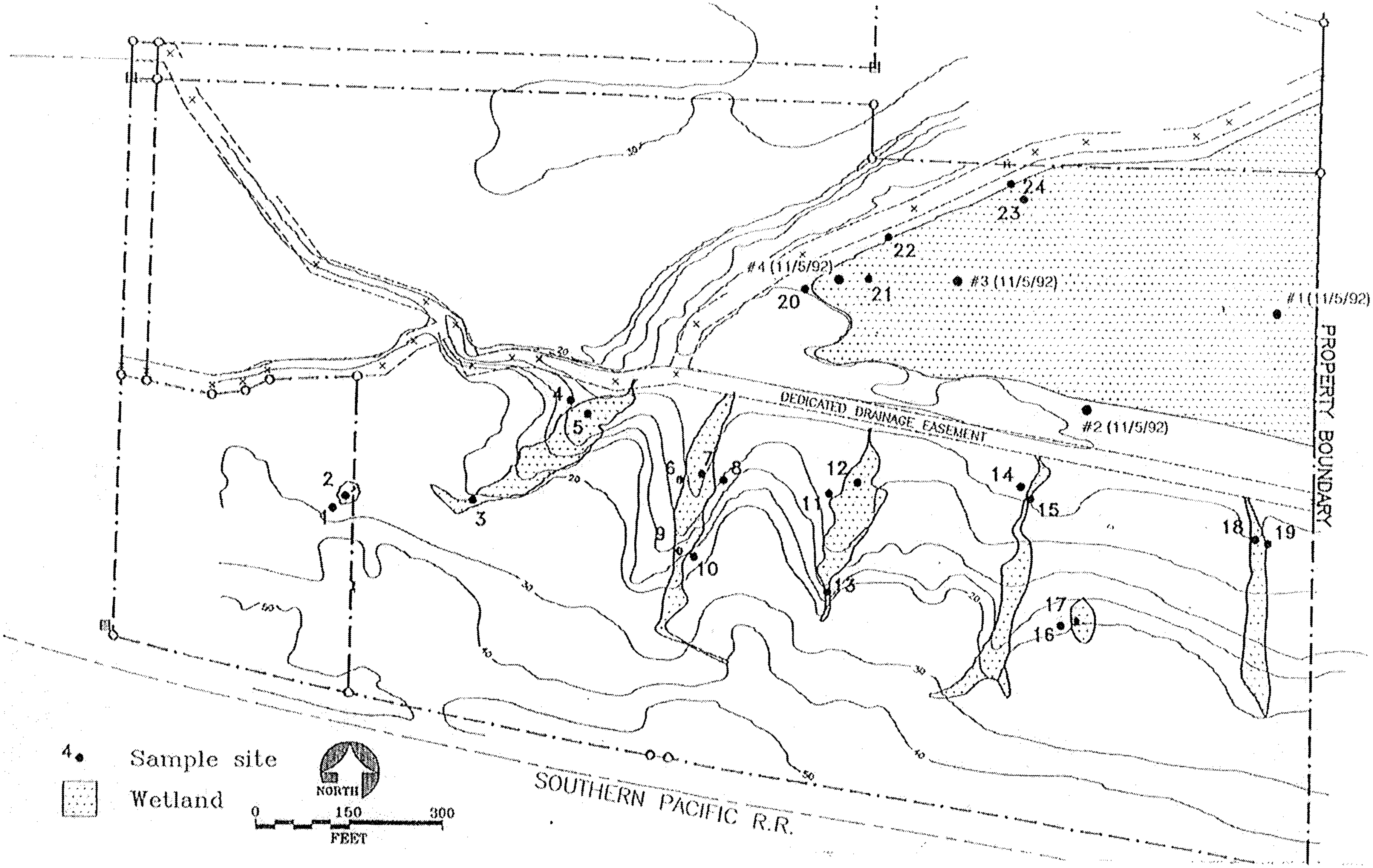

Figure 8. Galitzski Springs. (from SRI/Shapiro, 1993)

Table 5.3. Summary of Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas

	Wetland Benches	Buffalo Slough Culverts	Whitaker Slough Culverts	Galitzski Flats	Galitzski Springs	TOTAL
Lands and Damages	$ -	$ -	$150,000	$230,000	$155,000	$535,000
Non-Federal Sponsor's Costs	$ -	$ 7,500	$ 10,500	$ 20,000	$ 15,000	$ 53,000
Federal Review & Assistance Costs	$ -	$ 1,000	$ 3,000	$ 10,000	$ 10,000	$ 24,000
Subtotal	$ -	$ 8,500	$163,500	$260,000	$180,000	$612,000
Contingency	$ -	$ 2,000	$ 7,000	$ 20,000	$ 45,000	$ 74,000
Total	$ -	$ 10,500	$170,500	$280,000	$225,000	$686,000

5.4 Construction Restrictions

Special conditions were placed on construction of the wetland benches. Native vegetation and silt fencing will be used to aid in erosion control. Sediments within the slough will be handled so that "top" material dredged from undisturbed channel will be on the bottom of the piled material creating the bench. The excavation will be done with shallow cuts to get the top material on the bottom of the disposal site. Material will be placed rather than dumped.

These are additional special conditions placed by DSL on MCDD when MCDD did wetland benches (meandering channel) at Bridgeton Slough:

- Operation shall be conducted in a manner that will minimize any turbidity increase.
- In water work shall be conducted between June 15 and September 15 (we will try to get a waiver on this, since not directly connected to the Columbia or Willamette River except by pumps)
- Petroleum products, chemicals, or other deletorious materials shall not be allowed to enter the water.
- Fill materials and spoils shall be placed above the bankline unless utilized in the shaping and contouring of existing bankline.
- Removal of existing woody vegetation shall be the minimum necessary to achieve the project purpose.
- Areas of streambank disturbance shall be seeded or planted with grass and/or legumes. All exposed soils shall be stabilized immediately after project's completions to prevent erosion and sedimentation.
- The DSL retains the authority to temporarily halt or modify the project in case of excessive turbidity or damage to natural resources.

5.5 **Maintenance.** Non-native vegetation will be suppressed by cutting blackberries, reed canary grass and other exotic vegetation with chainsaws, weedeaters, hand tools or industrial mowing equipment. Workers will cut all resprouting exotic vegetation three times during the first year. In years two, three, and five, workers will cut brush once or twice in summer, depending on regrowth. BES will monitor planting survival and exotic vegetation regrowth, and prescribe additional treatments, as needed.

At the end of the 5-year establishment phase, native trees and shrubs should be well established. Stands of young hardwoods and conifers will become very dense, shading out most exotics. Maintenance in these stands should be minimal after 5 years. Shade tolerant weeds such as nightshade, English ivy, and holly will required continued monitoring and treatment. Areas planted with native shrubs, forbs, and wetland emergent plants will require extended maintenance.

Newly established stands will be managed in a variety of ways to achieve resource management objectives. Stands may be thinned to lower densities to allow establishment of understory vegetation and to increase growth of individual plants. Small patches within stands may be cut to provide a weed-reduced environment for the establishment of shrubs and forbs, or dense overstory may be maintained to minimize additional maintenance and planting costs.

5.6 Monitoring. BES has prepared monitoring and documentation guidelines to assess conditions and identify trends to increase continued success of planting projects. Monitoring includes assessment of plant mortality and its causes. BES will interplant areas where stocking falls below a level that will assure occupancy of the site by native plants within 10 years. BES may prescribe other treatments to further reduce plant mortality or to further enhance project areas.

5.7 Local Sponsor Support of Selected Plan. Coordination with the local sponsor and interested parties has been accomplished throughout the feasibility phase. The City of Portland has been conducting many other restoration projects in the Columbia Slough as part of its Columbia Slough Revitalization Plan. It has also played a major role in the development of the Total Maximum Daily Loads (TMDLs) for the watershed. The City of Portland, Bureau of Environmental Services, as well as the Multnomah County Drainage District No. 1, which operates the pump stations and maintains the drainage ways in Columbia Slough, have been closely involved in the development of the recommended plan, and suggested most of the alternatives considered.

SECTION 6. DRAFT ENVIRONMENTAL ASSESSMENT

6.1 Introduction

In the early 1930's, the Corps of Engineers recommended flood control improvements be constructed for Columbia Slough. These included levees and drainage systems in the four drainage districts existing at the time. The projects were authorized by Congress in 1936 and subsequently constructed. A 1993 report by the Corps found that these actions were responsible for fish and wildlife degradation. Under Section 1135 of the Water Resources Development Act of 1986, the Corps undertakes restoration of habitats degraded by previous Corps actions. Recent (1995) Corps guidance for ecosystem restoration identifies water quality as an important part of the ecosystem.

6.2 Purpose and Need

Corps' actions providing flood control resulted in interference with natural water flow in the Columbia Slough, degrading water quality and causing wetlands to dry out. The purpose of the proposed action is to improve water quality and create and restore wetlands along a segment of Columbia Slough.

6.3 Proposed Action and Alternatives

In conjunction with efforts by the project sponsor, the City of Portland, Bureau of Environmental Services (BES), the proposed action is to provide ecosystem restoration in Columbia Slough by improving water quality and creating wetlands. This action involves dredging 44,900 cubic yards (CY) of sediments from the slough between river miles (RM) 8.5 and 16, creating 9 acres of wetland benches within the slough, and creating a total of 1.0 acre of new riparian scrub-shrub habitat, 11.3 acres of emergent wetland habitat, and 1.7 acres of aquatic bottom habitat; restoring 18 acres of adjacent wetland and riparian habitat at Galitzski Springs and Galitzski Flats; and replacing five culverts in Buffalo Slough and Whitaker Slough to facilitate water flow, lower water levels, and create 19.7 acres of emergent wetland habitat (Figures 3a and 3b). Ecosystem restoration criteria include restoring riparian shrub-scrub and emergent wetland vegetation to optimal condition for selected target species, including yellow warbler and invertebrates. Improvements are measured as increased habitat units (HU) rather than acres.

Alternatives include no action, and more extensive restoration. No action would not respond to restoration needs. More extensive restoration is possible, but land values are rapidly escalating in this urban area, making many other options economically infeasible.

6.4 Affected Environment

Columbia Slough is about 18.5 miles long and is located just south of and parallel to the Columbia River in a highly developed industrial and residential area of north Portland. Levees constructed in the early 1900's cut off flushing from the Columbia River and divided the slough into two parts. The lower slough does not meet Oregon Department of

Environmental Quality requirements, suffering from stagnation, accumulation of industrial pollutants and toxic chemicals. Sediments are predominantly sand in the lower portions, changing to silt further upstream. Aquatic life consists predominantly of oligochaete worms in the benthos, some aquatic invertebrates, and various fish. Game fish include crappie, sunfishes, and white sturgeon. Juvenile chinook salmon are occasionally found during late spring high water conditions on the Willamette River, but the slough is not considered critical habitat for salmonids. Non-game species include sucker, carp, stickle back, pea mouth and cottids. The Colombia Slough levee is grass-covered: the riverward side is overgrown with reed canary grass and blackberry, the landward side is mowed.

Much of this area was low lying land with sloughs and wetlands prior to construction of the embankments. The water table is shallow and an internal drainage system of sloughs, ditches, culverted drainages and pumps has been installed over the decades. Soils are primarily hydric in origin. The area historically was highly disturbed, drained, filled, put into agricultural production, and built upon.

6.4.1 Physical Environment. Sediments in the middle portion of the slough are primarily silts and silty sand. Analysis from 1999 sampling (See Appendix A) indicates that sediments are composed of more than 20 percent fines, and some samples exceeded 5 percent volatile solids. Several samples contained DDT, though only one sample, in the upper reach of the slough near Fairview Lake, exceeded screening levels. Sources of the DDT are probably historic spraying for mosquito control as well as agricultural use. No other contaminants exceeding levels of concern were found.

Soils are silty loam to silty clay loam, very deep and poorly drained. Portions are considered "prime" by the Natural Resource Conservation Service when drained and protected from flooding: Sauvie silty clay loam; Sauvie silt loam; and Rafton silt loam. These soils are not in agricultural production at this time and are located within Portland's urban growth boundary.

6.4.2 Biological Environment. Several waterfowl species use the Columbia Slough habitat. Raptors such as red-tailed hawk, bald eagle and peregrine falcon are occasional visitors to the area. Columbia Slough receives limited recreational use, including canoeing, wildlife viewing and fishing. State and local authorities recently issued a warning against eating fish caught in Columbia Slough, due to high levels of PCB's and other toxic substances.

The unmowed portions of the embankments support some vegetation, including grasses, blackberry, nettles, black locust, ash, and cottonwood. Remaining habitat supports insects, frogs, snakes, voles, nutria, beaver, and a variety of birds including yellow warbler, downy woodpecker, black-capped chickadee, ducks and great blue heron. Various waterfowl species use the sloughs and ponds. No threatened or endangered species are known to inhabit the area; migrant peregrine falcon (de-listed) and wintering bald eagle may occasionally be seen in the general vicinity.

Predicted (with-project) values for yellow warbler were based on measurements of existing high quality riparian scrub shrub vegetation in the upper slough. Existing values for benthic invertebrates were based on extensive sampling of the sloughs; predicted values were based on published literature, unpublished reports, and personal communications.

6.4.3 Cultural Environment. The cultural environment of the watershed is previously discussed in this document in Sections 3.9 and 3.10.

6.5 Environmental Effects

6.5.1 Physical Environment. The physical environment of present-day Columbia Slough between RM 8.5 - 16 would be altered. About 44,900 cubic yards (cy) of sediment would be excavated, deepening the channel from elevation 6'CRD (Columbia River Datum) down to elevation 3' CRD in the upper slough (upstream of the mid-dike levee), and from elevation 5' CRD down to elevation 2'CRD in the middle slough. Most of this material would be placed on the bank side of the channel to form wetland benches. The material would be dredged in two lifts, with a barge-mounted bucket dredge skimming off the top 12"-18", placing it on the side of the channel. Material would then be dredged from a lower level and carefully placed on top of this material. These benches would be about 20 feet wide, with varying lengths on each side of the slough channel. The estimated total surface coverage is about 9 acres. Deepening and narrowing the channel would accelerate water flow, reducing stagnation. During the excavation and placement of material, short-term turbidity is expected to occur. Water management techniques would be employed to temporarily stop or reduce flow until the sediments settled out.

Sediments within the slough will be handled so that "top" material dredged from undisturbed channel will be on the bottom of the piled material creating the bench. The excavation will be done with shallow cuts to get the top material on the bottom of the disposal site. Material will be placed rather than dumped. Placing excavated material top down would reduce the probability that sediments containing DDT would enter the water system. Placement of material on top of existing sediments with DDT also keeps those sediments from contributing DDT to the system in the future. DDT in the sediments to be excavated does not exceed screening levels; however, it is beneficial to cover these sediments so that any DDT is less likely to become available in the ecosystem.

An estimated 3,600 cy of excess dredged material would be placed in 4-inch to 6-inch layers on the landward side of the main Columbia River levee along NE Marine Drive between NE 42nd Street and the I-205 bridge. The material will not have any direct contact or possibilities of running back into a waterway without first draining through several bio-swale systems, in order to filter out any sediments.

Replacement of four corrugated metal pipe (CMP) culverts with reinforced concrete pipe culverts on Buffalo Slough at Broadmoor and on Whitaker Slough at Colwood Golf Courses, together with installation of a 48" HDPE (high-density polyethylene) Spirolite culvert beneath NE 33rd Avenue, would involve excavation of 785 cy of material and placement of about 865 cy of material. About 185 cy of Class 100 rip rap per culvert , covering about 200 sq.ft. of surface area per culvert (1,000 sq. ft. total) would be placed to prevent erosion. The replacement culverts would allow for faster flow at lower elevations, a factor in water level management (see below).

6.5.2 Biological Environment. Faster water flow would reduce stagnation and algae blooms, and reduce water temperature. Non-productive aquatic bottom habitat would be replaced with emergent and shrub-scrub habitat.

6.5.3 Environmental Outputs. The construction of wetland benches will create or enhance three habitat types: riparian scrub-shrub, emergent wetland, and aquatic bottom. Table 5.1 includes the number of acres that would be affected by the project and the HUs and design elevations for each habitat type. Riparian scrub-shrub will be planted above the summer low water elevation, which is 5.5 feet in the middle slough and 8.5 feet in the upper slough. The maximum HUs would be obtained by establishing a dense cover of deciduous hydrophytic shrubs in this zone.

Emergent wetland will be created in the zone between the riparian scrub-shrub and approximately 3 feet below the mean summer water elevation. Although the maximum HUs for emergent wetland will be obtained in permanently flooded areas, water levels are anticipated to fluctuate slightly, alternately exposing and flooding habitat.

Aquatic bottom habitat is permanently flooded and occurs more than 3 feet below the low summer water elevation. This is generally the maximum depth at which emergent plants can grow. The emergent wetland and riparian scrub-shrub zones will enhance habitat for benthic invertebrates that occupy aquatic bottom habitat by providing organic plant material and structure. However, this improvement in aquatic bottom habitat will be slight because this zone is permanently flooded and sediments are generally unstable.

Existing bottom habitat is rated "poor" and supports few aquatic life forms. Approximately 13.7 acres of this poor habitat would be replaced by improved habitat for emergent and shrub-scrub species.

Water level management, such as a slow drawdown in late May or early June and taking 4-6 weeks to occur, will help create a more diverse vegetative cover. Maintaining high water levels (over 18") through June in some years will help suppress reed canary grass.

Riparian shrubs should dominate wetland bench vegetation at elevations above the mean low water level. Shading exceeding 80 percent has been shown to suppress reed canary grass biomass. Riparian shrubs such as willows, spiraea, and red-osier dogwood are hydrophytic shrubs, which can withstand flooding and perform well in environments with fluctuating water levels.

6.5.4 Wetland Restoration, Galitzki Springs. The subject parcel, with its hydric soils, historical wetland, and perennial springs, offers unique restoration opportunities. The well-shaded springs provide a year-round source of cool water to the riparian area. The juxtaposition of the cottonwood-ash, mixed hardwood, and wet meadow habitats makes this one of the most valuable restoration opportunities in the project area.

Restoration would focus on re-creating wetland and open-water habitat in the Galitzki Flats, and increasing forest cover, improving age-distribution, and snag recruitment in Galitzki Springs. This would be accomplished primarily through wetland construction, invasive plant control and revegetation. Wetland construction would provide 3.4 acres of open water and 5.0 acres of emergent wetland, for a total of 6.7 new HUs. Restoration in forested areas would provide 5.5 acres of cottonwood-ash and 2.4 acres of mixed hardwood-conifer, for a total of 2.8 new HUs. The 2.7 acres of riparian scrub-shrub would be enhanced to provide 1.1 new HUs. Thus, the proposed restoration of the Galitzki Springs and Flats would provide 10.6 new HUs.

The proposed restoration would result in 9.7 AAHUs over the 50-year life of the project. Maximum habitat values would be achieved at 5 years in the wetlands and at 20 years in the forest habitats. The longer period for forested habitats is due to the time required for snag recruitment and to achieve proper stocking levels.

TABLE 6.1. Summary of environmental outputs.

		HABITAT UNITS			
PROPOSED ALTERNATIVE	ACRES	EXISTING	W/ ALT.	NEW	AAHU
Wetland Bench	36.5	4.1	18.1	14.0	13.5
Galitzki Spring & Flats	19.1	6.7	17.3	10.6	9.7
Buffalo Slough Culverts	16.7	1.1	7.4	6.3	6.1
Whitaker Slough Culverts	51.7	4.3	18.4	14.1	13.6
TOTAL	162.5	26.3	96.2	69.9	64.2

6.5.5 Cultural Environment. Due to the environmental overlays, land use is restricted in most of the project area. Most of the proposed action would occur within the banks of Columbia Slough and would not affect land use. The 9 acres of Galitski Flats are zoned IG2p, industrial sanctuary with preservation overlay. Use of this land for industry is very limited due to the overlay and access problems. Adjacent lands, also zoned for industrial sanctuary, are available for industrial development. The loss of 4 acres of industrial land, converted back to wetland, is insignificant.

With improvement in water quality in this section of the slough, recreational activities would be expected to increase.

The culvert replacements would occur in areas of previous disturbance and should not require additional cultural resource investigations, since all of this work would be in ground that was previously disturbed. The Galitzki Flats restoration is located in a high probability area for prehistoric cultural resources as discussed in the Description of the Environment.

Prior to restoration activities, Galitzki Flats area would be surveyed for cultural resources by a professional archaeologist who is familiar with the cultural resources of the South shore area and who meets professional qualifications as provided in Appendix A to 36CFR 61. Based on the results of this survey additional cultural resource efforts may be necessary to preserve or mitigate project impacts to important cultural resources within the project area. With survey and any necessary mitigation, impacts to cultural resources are expected to be minor.

6.6 Project Coordination

The proposed action has been coordinated with the sponsors, the City of Portland and Multnomah County Drainage District. Through the sponsors' efforts, the project has been coordinated with State and Federal resource agencies, local interest groups, and members of the public. Once the proposed action is approved and in the plans and specifications stage, the City of Portland will conduct Environmental Reviews under Title 33.515.280 of the Planning and Zoning code.

This Environmental Assessment will be distributed for 30-day public review. Review comments are requested from Federal, State, and local agencies and groups, including:

U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Federal Emergency Management Agency
Oregon Department of Environmental Quality
Oregon Division of State Lands
Oregon State Historic Preservation Office
Portland Bureau of Planning
Portland Bureau of Parks
Multnomah County Drainage District No. 1
Kenton Neighborhood
North Portland Neighborhood

6.7 Consultation Requirements

- Clean Water Act of 1977: Section 402 of the Clean Water Act will be complied with. Construction/stormwater permits under the National Pollutant Discharge Elimination System (NPDES) would be required due to the size of the area disturbed by construction (more than 1 acre). A Section 404 (b)(1) water quality evaluation has been prepared (Appendix C). Water quality certification under Section 401 of this act will be requested from the Oregon Department of Environmental Quality.

- Coastal Zone Management Act: The proposed action is outside the coastal zone. A Coastal Zone Consistency Determination is not required.

- Endangered Species Act of 1973, as amended: No listed threatened or endangered species would be affected by the proposed action. Critical habitat for listed salmonids does not include Columbia Slough. The threatened bald eagle may winter in the vicinity of the project. A biological assessment, concluding no effect, was submitted to the U.S. Fish and Wildlife Service. (*See Exhibit 7 in the main report.)

- Fish and Wildlife Coordination Act: The proposed action is in compliance with the requirements of this act. A Coordination Act review has been requested from the USFWS.

- Marine Protection, Research, and Sanctuaries Act of 1972, as amended: No marine resources would be affected by the proposed action.

- Cultural Resources Acts: A cultural resources investigation determined that no cultural resources would be affected by activity at culvert replacement, dredging locations and bench creation sites due to the extent of past disturbance. Galitzki Flats requires survey. The Oregon State Historic Preservation Office will be consulted and is expected to concur in this finding.

- Executive Order 11988, Flood Plain Management, 24 May 1977: The proposed restoration would have no effect on the existing flood plain nor encourage further development in the flood plain. Restoration of Galitzki Flats would prevent industrial development on that acreage.

- Executive Order 11990, Protection of Wetlands: No wetlands would be adversely affected by the proposed action. 38 acres of wetlands would be restored.

- Analysis of Impacts on Prime and Unique Farmlands: Project lands are determed to be Prime Farmlands when drained based on three soil series: Chehalis silty clay loam, occasionally flooded; Newberg fine sandy loam; and Cloquato silt loam. The proposed action would restore wetlands that had previously been drained and farmed, rendering them no longer prime farmlands. These lands are, however, all within the Portland metropolitan area Urban Growth Boundary, and are thus no longer subject to the Farmland Protection Policy Act.

- Comprehensive and Environmental Response, Compensation and Liability Act (CERCLA). The location of the proposed project is not within the boundaries of a site designated by the EPA or a State for a response action under CERCLA, nor is it a part of a National Priority List site under CERCLA. DDT, below screening levels, has been found in the dredge sediments at several locations. These sediments would be placed on the bottom of created wetland benches and covered with cleaner material. One location, where screening levels were exceeded, would not be disturbed. Should any other hazardous, toxic or radioactive material be discovered during construction, its presence will be responded to within the requirements of the law and USACE regulations and guidance.

SECTION 7. COST ESTIMATE AND SCHEDULE

7.1 Project Cost Estimate. The total project cost in October 2000 price levels and conditions is $4,154,000, including costs for the Section 1135 feasibility report. The fully funded implementation cost is $4,566,000 (October 2002 price levels, with staged construction). The local sponsor's share is $1,038,000 (October 2000 price level), which includes the value of land, easements, rights-of-way, relocations, and disposal areas (LERRD), estimated at $689,000. The fully funded sponsor's share is estimated at $1,141,000. The Federal portion is $3,116,000 (October 2000 price level), which is 75% of the total project cost, based on the cost sharing requirements as contained in Section 1135 of the 1996 Water Resources Development Act, as amended, Public Law 99-662. The fully funded Federal share is estimated at $3,425,000. The average annual costs, evaluated at 6-5/8% percent interest rate over the 50 year economic analysis period in 2000 prices, including allowance for operation and maintenance, amount to $210,000. Maintenance costs are estimated as $2,000 annually. Plans and specifications are estimated to cost $262,000. Four separate construction contracts are anticipated: one for the wetland benches, one for the smaller culverts at Buffalo Slough and Whitaker Slough, one for the NE 33rd Avenue culvert, and one for the constructed wetland and riparian restoration at Galitzski Flats / Springs.

7.2 Operation and Maintenance. The non-federal sponsor (City of Portland) is responsible for all operation and maintenance of the proposed project. During the first two years after planting, sites will be hand-irrigated if severe hot and/or dry weather jeopardizes young plants.

Non-native vegetation will be suppressed by cutting blackberries, reed canary grass and other exotic vegetation with chainsaws, weedeaters, hand tools or industrial mowing equipment. Workers will cut all resprouting exotic vegetation three times during the first year. In years two, three and five, works will cut brush once or twice in the summer, depending on regrowth. Planting survival and exotic vegetation regrowth will be monitored, and additional treatments prescribed, as needed.

7.3 Design and Construction Schedule. The design and construction schedule (Table 7.1) will be dependent on Congressional appropriations for the Section 1135 program. The following schedule is based on the assumption that design and initial construction funds would be made available in FY 2001.

There are four separate contracts anticipated for this project:

- Wetland benches
- Culverts at Buffalo Slough and Whitaker Slough
- NE 33rd Culvert
- Galitzski Flats / Springs

Design for each of the contracts could be initiated in FY 2001. Design for the wetland benches will use the knowledge learned in construction of similar wetland benches at

Bridgeton Slough within MCDD #1. Design of wetland benches for a 3,000-ft. segment could be done in FY 2001. Conventional designs will be used for the culverts at the golf course crossings at Colwood and Broadmoor Golf Courses. These could be designed for construction in FY 2002. The real estate for the constructed wetland at Galitzski Flats has already been purchased by the City of Portland, so construction could begin as soon as plans and specifications are completed and construction funds are available. Easements will be required for construction of the wetland benches and the culverts in Buffalo Slough and Whitaker Slough. Construction could be initiated on segments of the wetland benches as early as FY 2001. The wetland benches would require 2-3 years to complete. Real estate acquisition for the Galitzski Springs site is not anticipated to occur until FY 2003, with restoration activities occurring the following year.

7.4 Non-Federal Responsibilities. The non-federal sponsor (City of Portland) is responsible for the operation and maintenance requirements, as described above. Additionally, the City will provide all necessary lands, easements, rights-of-way, relocations, and dredged disposal sites (LERRD) for construction and operation / maintenance of the project in perpetuity (including a disposal site for any waste material). All LERRD which the City provides will be credited towards the overall 25% local share of the implementation costs. The City has already purchased the Galitzski Flats site. An estimated $429,000 in additional LERRD requirements for the City is anticipated (for a total of $689,000). The City will also provide an estimated $257,000 of in-kind services, primarily related to vegetation plantings along the wetland benches and riparian restoration at the Galitzski Springs site. Additional cash requirements of $195,000 from the City are anticipated.

Table 7.1
Design and Construction Schedule

	FY 2001			FY 2002			FY 2003			FY 2004		
		Local			Local			Local			Local	
	Fed	In-Kind	Cash	Fed	In-Kind	Cash	Fed	In-Kind	Cash	Fed	In-Kind	Cash
Feasibility Report	37											
Wetland Benches												
LERRD		15										
Design	20			20	7		15	4				
Construction	57		23	300	10		300	50			56	
Slough Culverts												
LERRD					181							
Design				28								
Construction				290								
NE 33rd Ave Culvert												
LERRD								3				
Design				105								
Construction							1267		62			
Galitzski Flats												
LERRD					280							
Design				52								
Construction				625								
Galitzski Springs												
LERRD								225				
Design								10				
Construction											112	
TOTAL	114	15	23	1420	478	0	1582	292	62	0	168	0
Federal Total			114			1534			3116			3116
Non-Federal Total			23			501			855			1023

SECTION 8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions. This study has included an examination of all practical alternatives for meeting the study objective of restoring habitat within the 10-mile reach of Columbia Slough that have been affected by the Corps' flood control levees. The selected alternative, consisting of the construction of wetland benches along 7.5 miles of the main slough, replacement of five culverts within Buffalo Slough and Whitaker Slough, restoration of a wetland at Galitzski Flats (formerly Duck Lake), and riparian restoration at Galitzski Springs, is the most effective alternative which also meets the sponsor's needs. This alternative provides significant ecosystem benefits, at a reasonable construction and O&M cost. The plan does not impair the original Federal project of flood control, and is consistent with national policy, statutes, and administrative directives. The plan has been reviewed in light of overall public interest, which includes the views of the local sponsor and interested agencies. The District has concluded that the City of Portland is capable of meeting their financial obligations and that the total public interest would be served by implementation of the recommended plan.

8.2 Recommendations.

I recommend that the proposed work be authorized and funding allotment of $20,000 for the initial Plans and Specifications phase and $57,000 be made available for the initial phase of construction. The proposed work will consist of the construction of wetland benches along 7.5 miles of the main slough, replacement of five culverts within Buffalo Slough and Whitaker Slough, restoration of a wetland at Galitzski Flats (formerly Duck Lake), and riparian restoration at Galitzski Springs, as generally described in this report, with such modifications by the Chief of Engineers as may be advisable to meet provisions of Section 1135 of the 1996 Water Resources Development Act, as amended. Initial construction shall consist of construction of wetland benches along 3,000 feet of the main Columbia Slough. Authorization is subject to cost sharing and financing arrangements with the local sponsor, the City of Portland, and is based on the cost sharing and financing arrangements of the Section 1135 program. Prior to construction of each phase, and during Plans and Specifications phase, the local sponsor will: provide all lands, easements, and rights of way necessary for the project; hold and save the United States free from damages due to the construction or operation and maintenance of the project; and operate and maintain the project after construction.

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Date

____
Randall J. Butler
Colonel, Corps of Engineers
District Engineer

REFERENCES

Berger, C.J. and S.A. Wells. 1999. Hydraulic and Water Quality Modeling of the Columbia Slough. Volume 1: Model Description, Geometry, and Forcing Data. Portland State University

City of Portland, Bureau of Planning. 1989. Inventory and analysis of Wetlands, Waterbodies, and Wildlife Habitat Areas for the Columbia Corridor.
Century West. *Final Report for Master Drainageway Plan*, presented to Multnomah County Drainage District No.1. March 1989

CH2M Hill. *Water Body Assessment, Columbia Slough TMDL Development.* November 1995.

CH2M HILL and Associated Firms. 1995. *Part 2 – Pollutant Sources and Controls. Water Body Assessment, Columbia Slough TMDL Development.* City of Portland, Bureau of Environmental Services.

Crawford Engineering Associates. Watershed Model of the Columbia Slough, Memorandum to LTI / Port of Portland. January 2000.

Crawford Engineering Associates. *Multnomah Drainage District No. 1 Summary Report of Data Compilation and Modeling.* August, 1997.

Crawford Engineering Associates. Water Levels near 185th and Upper Columbia Slough, Memorandum to Multnomah County Drainage District No.1. October 1998.

Crawford Engineering Associates. "Water Level Management and Deicing Flow Coordination." Memorandum to Multnomah County Drainage District No. 1/ LTI. March 1999.

Federal Emergency Management Agency. Flood Insurance Risk Maps. Community Panel No. 410183-0020D, 410183-0025D, and 410183-0065A. Revised January 1986.

Fishman Environmental Services. 1988. Columbia Slough Master Plan, Task Report, Fish and Biological Studies, Fish and Fish Habitat. Prepared for City of Portland.

Fishman Environmental Services. 1989. Columbia Slough Water Quality Management Plan, Aquatic Biology Final Report: Benthic Inverterbrates, Fish and Bioaccumulation. Prepared for City of Portland.

HDR Engineering. 1993. *Columbia Slough Program Plan, Volume II, Technical Report.* Prepared for City of Portland, Bureau of Environmental Services. December 1993.

HDR Engineering, Inc. and Associated Firms. 1993b. *Executive Summary, Columbia Slough Program Plan.* City of Portland, Bureau of Environmental Services.

Oakley Engineers. *Multnomah County Drainage District No.1, Upper Columbia Slough, Hydraulic Capacity Alternatives Analysis.* July 1992

Parametrix. 1995. *Columbia Slough Sediment Project Screening Level Risk Assessment.* Prepared for the City of Portland, Bureau of Environmental Services. February 1995.

Portland State University. 1997. *North Portland, An Urban Ecosystem.*

SRI/Shapiro. 1993. *Wetland Determination and Delineation of a Proposed Columbia South Shore Development Site in Multnomah County, Oregon.*

U.S. Army Corps of Engineers, Portland District. *Peninsula Drainage District No.1, Detailed Project Report, Section 205.* September 1996.

U.S. Army Corps of Engineers, Portland District. December 1998. Summary Report: Lower Columbia Slough Section 1135 Ecosystem Restoration Project.

Wells, S.A., Annear, R.L., Jr. and C. Berger. 1998 (draft). Feasibility Analysis for Wetland Benches in the Lower Columbia Slough. Portland State University. Prepared for Corps of Engineers, Portland District.

Wells, S.A. and Berger, C. 1994. *Upper and Lower Columbia Slough Water Level Test: September 1 through October 29, 1993.* Technical Report EWR-2-94, Department of Civil Engineering, Portland State University, Portland, Oregon.

APPENDIX A

Columbia Slough
Sediment Quality Evaluation

Columbia Slough Meandering Channel/Wetland Benches Project

Fact Sheet

Project Purpose

Creation of a meandering channel over various segments of a 10-mile stretch of the mainstem of the Middle and Upper Columbia Slough. The intended function of the channel deepening is to increase velocities to improve water quality during the low flow season and to provide wildlife and wetland habitat.

Project Description

The U.S Corps of Engineers is conducting a General Investigation (GI) Feasibility Study to evaluate a meandering channel in the Slough mainstem for water quality, wildlife and wetland enhancement benefits. Dredging would be conducted to an elevation of approximately 3 feet and the dredged material would be used to create wetland benches. These benches would be vegetated to support wildlife. Side casting would be used to create the meanders during low-water periods. The Multnomah County Drainage District (MCDD) which is responsible for maintaining the Slough channels would obtain the required 404/401 permits for conducting this project.

Project Background

Historical Chemistry Data Review

Historical data were reviewed to evaluate potential sediment issues related to inwater disposal (side casting) of Slough sediments. Numerous surface samples have been taken in the Slough mainstem on various dates and numerous locations. Most of the analyses were below the screening levels (SLs) of the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). Table 1 shows the exceedances of the SLs. Those analyses exceeding the SLs were 4 heavy metals, 3 phenol groups, 2 phthalate groups, 1 alcohol and 1 pesticide.

Sediment Sampling

After review of these data, the U.S Corps of Engineers conducted additional sampling to characterize the sediment of portions of the middle and upper Columbia Slough mainstem.

The US Army Corps of Engineers, Portland District personnel collected gravity core samples on May 18-19, 1999. The study area was divided into 8 sampling areas (see attached figure). The eight sampling composite areas were selected to give balanced coverage to the full-length study. Twenty-two individual cores were collected and composited with 3 samples per area (except area 7, one sample only). The eight composite core samples were divided, with the top representing the dredging prism and the bottom 6" to 12", representing the "newly exposed surface" after dredging is completed. Samples were analyzed for the following:

- Physical and Volatile Solids
- Metals and Total Organic Carbon (TOC)
- Pesticide/PCBs, Phenols, Phthalates and Misc. Extractables

- Polynuclear Aromatic Hydrocarbons (PAHs)

With few exceptions, the newly exposed surface has chemicals of concern at lower levels than the material in the dredging prism. The pesticide DDT was the only compound found in excess of the SL (6.9 ug/kg). Of 16 samples analyzed for DDT, 10 exceeded the SL with levels ranging from 7.1 to 51.3 ug/kg (Table 2). The bioaccumulation level of concern is 50 µg/kg; only one sample (CS-GC-08A in the dredging prism) exceeded this level at 51.3 µg/kg.

Biological Testing

Tier III biological testing was recommended to characterize potential biological effects from inwater disposal because of the DDT sediment concentrations greater than the SL and bioaccumulation level of concern. A list of dredging scenarios was developed from preliminary discussions of the meandering channel design to aid in determining what kind of bioassay sampling should be conducted. Table 3 provides information on proposed dredge locations and volumes, and the associated DDT concentrations in each area.

A review team, including DEQ, the Corps, the City of Portland, and MCDD recommended that five composite samples be collected, one each from Areas 1, 3, 4, 5, and 8. Each composite sample was comprised of three sediment samples collected from each area with a gravity core. The bioassays consisted of tests for 2 species (Amphipod – *Hyalella azteca* 10-day survival test and Midge – *Chironomus tentans* 10-day survival and growth test). The bioaccumulation test was conducted on one species (Oligocheate – *Limbriculus variegatus* 28-day tissue tesidue test). The testing is summarized below.

Area	Composite Bioassay Test	Composite Bioaccumulation Test	Composite DDT and Grain Size Analyses	# Samples/ composite
1[a]	1	1	1	3
2	--	--	--	None
3	1	--	1	3
4	1	--	1	3
5	1	--	1	3
6	--	--	--	None
7	--	--	--	None
8	1	1	1	3
[a] Reference site				

The results of the acute and chronic testing are summarized in Table 4. The amphipod results were inconclusive because the reference area failed to meet the acceptable survival criterion. The results of the midge bioassays indicated significant effects for survival in one sample (Area 3) and for growth in one sample (Area 8), but the results were somewhat inconclusive. Several things may have contributed to inconclusive results. Temperature and pH were slightly outside the recommended ranges. Ammonia levels, while not lethal, may have caused stress in some samples. It was noted that the reference and test sediments had significant amount of woody debris (small wood chips); wood chips contain resin alkaloids that are known to be acutely lethal to many benthic invertebrate species. None of these factors can be determined to be conclusive for the outcome of the bioassays.

The bioaccumulation testing for Area 8 was evaluated by comparing DDT tissue residues of organisms exposed to the test sediment with tissue residues of animals exposed in parallel to the reference sediment CS-HC-01R. Results of the tissue analysis indicate that measured DDT tissue residues were nearly all below the method detection limit (1.0 µg/kg) in organisms exposed to the test sediment (Table 5). All measured concentrations in both the test and reference organisms were well below the FDA action limit of 5,000 µg/kg (given as the sum of DDE & DDT).

Since DDT is known to biomagnify in aquatic food webs, trophic transfer coefficients from the published literature were used to estimate potential risk to higher trophic organisms (i.e., fish consuming benthic infauna, piscivorous birds, and humans consuming fish). A biomagnification factor (BMF) of 30 was used to estimate the resultant tissue concentration in fish consuming *L. variegatus* with the measured DDT residues. Based on this analysis, the measured tissue residues in the test sediment exposed organisms represents little to no risk to wildlife or humans. A similar evaluation of tissue residues in reference exposed organisms (which were higher than test sediment exposed organisms) showed that the measured tissue residues do not represent a significant risk to benthic infauna. Additionally, based on the conservative screening level assessment provided above, these measured DDT residues in reference exposed organisms appear to represent little to no risk to higher trophic organisms (predatory fish and Bald Eagles). Finally a comparison of estimated fish tissue residues (derived from reference site exposed organisms) results in human health risks comparable to that for fish obtained from the market.

Next Steps

The chemical testing conducted by the Corps in May 1999 indicated that the only contaminant exceeding the DMEF screening levels was DDT. Subsequent biological testing indicated no risk for bioaccumulation but the bioassay testing was somewhat inconclusive.

The project team proposes to the DMMT that this project be allowed to proceed based on 40 CFR 230.60 (c):

> "To reach the determinations in Sec. 230.11 involving potential effects of the discharge on the characteristics of the disposal site, the narrative guidance in subparts C through F shall be used along with the general evaluation procedure in Sec. 230.60 and, if necessary, the chemical and biological testing sequence in Sec. 230.61. Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing will not be required." [Full text of 230.60 provided in Attachment A]

The 40 CFR 230.11 provides guidance of factual determinations for making findings of compliance or non-compliance with the restrictions on discharge [Full text of 230.11

provided in Attachment B]. The determinations of effects of each proposed discharge shall include the following:

(a) **Physical substrate determinations.** The purpose of this evaluation is determine if changes outside of the disposal site may occur as a result of erosion, slumpage, or other movement of the discharged material.

The project incorporates stabilization of the side-casted material with vegetation to prevent erosion or other movement of the dredged material.

(b) **Water circulation, fluctuation, and salinity determinations.** Requires determination of the nature and degree of effect that the proposed discharge will have individually and cumulatively on water, current patterns, circulation including downstream flows, and normal water fluctuation.

The project is designed to improve water circulation and quality.

(c) **Suspended particulate/turbidity determinations.** Requires determination of the nature and degree of effect that the proposed discharge will have, individually and cumulatively, in terms of potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site.

Measures will be taken to minimize suspension of particulates, including stopping flow in the Slough during the activity and stabilization of the dredged benches after placement. Because MCDD can control flows and water levels within the project area, effective controls during construction of the project can be implemented. Long-term benefits of the project include increased solids retention by vegetation on the benches.

(d) **Contaminant determinations.** Requires determination of the degree to which the material proposed for discharge would introduce, relocate, or increase contaminants.

Proposed project will not increase contaminant, since material is being placed within the general area that it is dredged. Even if all material was disposed upland, the long-term redeposition of the same contaminants from the watershed is anticipated in the Slough.

(e) Aquatic ecosystem and organism determinations. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms.

Project designed to enhance structure and function of aquatic and wetland ecosystems.

Table 1. Historical Columbia Slough Sediment Project Data[1]									
Sampling Area	Sample ID	Parameter	VALUE	Q	LCRMA Screening Levels[2]	Value Exceeds LCRMA	UNITS	DL	PQL
1	CSUTS002100	4-Methylphenol	3300	E	670	x	ug/kg-dry	28	87
	CSUTS002100-DL	4-Methylphenol	3100		670	x	ug/kg-dry	55	170
	CSURS014300	Total DDT	12.3		6.9	X	ug/kg-dry	NA	NA
	CSURS025400	Total DDT	8.5		6.9	X	ug/kg-dry	NA	NA
	CSURS068500	Total DDT	12.2		6.9	X	ug/kg-dry	NA	NA
	CSURS068500-DL	Total DDT	9		6.9	X	ug/kg-dry	NA	NA
	CSURS110200	Total DDT	15.6		6.9	X	ug/kg-dry	NA	NA
	CSURS123500	Total DDT	13.1		6.9	X	ug/kg-dry	NA	NA
	CSUTS001500	Total DDT	13.8		6.9	X	ug/kg-dry	NA	NA
2	CSURS235500	Benzyl Alcohol	65	JM	57	x	ug/kg-dry	22	140
	CSURS175200	Total DDT	24.3		6.9	X	ug/kg-dry	NA	NA
	CSURS175200-DL	Total DDT	17.2		6.9	X	ug/kg-dry	NA	NA
	CSURS195400	Total DDT	9.4		6.9	X	ug/kg-dry	NA	NA
	CSURS212100	Total DDT	23		6.9	X	ug/kg-dry	NA	NA
	CSURS235500	Total DDT	44.1		6.9	X	ug/kg-dry	NA	NA
	CSURS265200	Total DDT	9.1		6.9	X	ug/kg-dry	NA	NA
	CSURS294500	Total DDT	17.7		6.9	X	ug/kg-dry	NA	NA
	CSURS308100	Total DDT	25.8		6.9	X	ug/kg-dry	NA	NA
	CSURS329400	Total DDT	7.4		6.9	X	ug/kg-dry	NA	NA
	CSUTS302500	Total DDT	9.8		6.9	X	ug/kg-dry	NA	NA
3	CSURS436400	4-Methylphenol	1400		670	x	ug/kg-dry	47	150
	CSURS416100	Total DDT	18.4		6.9	X	ug/kg-dry	NA	NA
	CSURS436400	Total DDT	9.2		6.9	X	ug/kg-dry	NA	NA
4	CSURS485200	2,4-Dimethylphenol	1000		29	x	ug/kg-dry	150	460
	CSURS485200	2-Methylphenol	460		63	x	ug/kg-dry	85	270
	CSURS485200	Benzyl Alcohol	1300		57	x	ug/kg-dry	44	290
	CSURS496400	4-Methylphenol	1200		670	x	ug/kg-dry	22	70
	CSURS496400	Total DDT	15.5		6.9	X	ug/kg-dry	NA	NA
	CSURS533300	Total DDT	15		6.9	X	ug/kg-dry	NA	NA
	CSURS573200	Total DDT	17.5		6.9	X	ug/kg-dry	NA	NA
	CSURS585500	Total DDT	9.2		6.9	X	ug/kg-dry	NA	NA
	CSURS604500	Total DDT	8		6.9	X	ug/kg-dry	NA	NA
	CSURS623200	Total DDT	27.9		6.9	X	ug/kg-dry	NA	NA
	CSUTS501300	Total DDT	17.9		6.9	X	ug/kg-dry	NA	NA
	CSUTS602300	Total DDT	23.1		6.9	X	ug/kg-dry	NA	NA
	CSUTS502100	4-Methylphenol	880		670	x	ug/kg-dry	16	52
	CSURS604500	4-Methylphenol	800		670	x	ug/kg-dry	27	85
5	CSSTS002500	Lead	510		450	x	mg/kg-dry		
	CSSTS002500	Zinc	722		410	x	mg/kg-dry		
6	CSSTS101500	Bis(2-Ethylhexyl)Phthalate	11000	E	8300	x	ug/kg-dry	10	32
	CSSTS101500-DL	Bis(2-Ethylhexyl)Phthalate	38000		8300	x	ug/kg-dry	310	960

Table 1. Historical Columbia Slough Sediment Project Data[1]									
Sampling Area	Sample ID	Parameter	VALUE	Q	LCRMA Screening Levels[2]	Value Exceeds LCRMA	UNITS	DL	PQL
	CSSRS119300	Mercury	0.51		0.41	x	mg/kg-dry		
	CSSRS058100	Total DDT	13.7		6.9	X	ug/kg-dry	NA	NA
	CSSRS093200	Total DDT	36.2		6.9	X	ug/kg-dry	NA	NA
	CSSTS102500	Bis(2-Ethylhexyl)Phthalate	40000	E	8300	x	ug/kg-dry	170	550
	CSSTS102500-DL	Bis(2-Ethylhexyl)Phthalate	31000		8300	x	ug/kg-dry	350	1100
	CSSTS102500	Butylbenzyl Phthalate	1100	M	970	x	ug/kg-dry	96	300
	CSSTS102500	Cadmium	36		5.1	x	mg/kg-dry		
	CSSTS102500	Lead	510		450	x	mg/kg-dry		
	CSSTS102500	Zinc	1320		410	x	mg/kg-dry		
	CSSTS102501	Bis(2-Ethylhexyl)Phthalate	59000	E	8300	x	ug/kg-dry	130	400
	CSSTS102501-DL	Bis(2-Ethylhexyl)Phthalate	32000		8300	x	ug/kg-dry	1300	4000
	CSSTS102501	Cadmium	84		5.1	x	mg/kg-dry		
	CSSTS102501	Lead	520		450	x	mg/kg-dry		
	CSSTS102501	Zinc	1310		410	x	mg/kg-dry		
8	EDSTS201600	Dieldrin	0.02		0.01	x	mg/kg-dry		0.01
	CSSRS220400	4-Methylphenol	790		670	x	ug/kg-dry	26	83
	EDSTS202600	Dieldrin	0.02		0.01	x	mg/kg-dry		0.01
	CSSRS205300	Total DDT	9.9		6.9	X	ug/kg-dry	NA	NA
	CSSRS220400	Total DDT	16.6		6.9	X	ug/kg-dry	NA	NA
	CSSTS202500	Bis(2-Ethylhexyl)Phthalate	3800	E	8300		ug/kg-dry	17	54
	CSSTS202500-DL	Bis(2-Ethylhexyl)Phthalate	16000		8300	x	ug/kg-dry	140	430

[1] Data from the City of Portland: Columbia Slough Sediment Project, Screening Level Risk Assessment Report, Feb.1995. Only exceedances are shown.

[2]Source: USACE. 1998. Dredged Material Evaluation Framework, Lower Columbia River Management Area Draft.

Screening level = Concentrations at or below which there is no reason to believe that dredged material disposal would result in unacceptable adverse effects due to toxicity measured by sediment bioassays (suitable for aquatic disposal without the need for biological testing). These screening values were developed for the marine environment, freshwater values are under development.

Notes:

No qualifier definitions were given with database.

Table 2. Columbia Slough GI Study Pesticides (ug/kg) Results, Sampled May 18-19, 1999													
Sample I.D.	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Aldrin	Dieldrin	Alpha-BHC	Delta-BHC	Endosulfan 1	Endrin	Endrin aldehyde	Hepta chlor	Hepta chlor epoxide
CS-GC-01A	<0.58	*2.1*	<2.0	*2.1*	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-A (DUP-01A)	*1.8*	*3.5*	<2.0	*5.2*	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-01B	<0.33	<0.69	<2.4	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02A	*2.8*	*2.5*	<1.8	*5.3*	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02B	<0.26	<0.54	<1.9	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03A	*4.3*	*6.5*	<2.2	**10.8**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03B	*1.9*	*2.8*	<1.8	**4.7**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-04A	*5.5*	*8.9*	<2.1	**14.4**	<0.12	<0.11	<0.12	<0.12	*1.2*	<0.19	*12*	<0.16	<0.26
CS-GC-04B	*1.7*	*1.3*	<1.7	**3.0**	<0.12	<0.11	<0.12	*0.37*	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-05A	*14*	*17*	<2.4	**31.0**	*1.6*	*0.94*	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	*0.46*
CS-GC-05B	*3.9*	*7.4*	<2.1	**11.3**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-06A	*6.3*	*8.6*	<2.4	**14.9**	<0.12	<0.11	*0.39*	<0.12	*0.72*	<0.19	<1.4	<0.16	<0.26
CS-GC-06B	*2.8*	*4.3*	<1.7	**7.1**	<0.12	<0.11	<0.12	*0.24*	<0.51	<0.19	<1.4	*0.17*	<0.26
CS-GC-07A	*14*	*29*	<3.2	**43.0**	<0.12	<0.11	*0.71*	<0.12	<0.51	<0.19	*5.1*	<0.16	*0.58*
CS-GC-07B	*16*	*22*	*3.9*	**41.9**	<0.12	<0.11	<0.12	<0.12	*1.1*	<0.19	<1.4	<0.16	<0.26
CS-GC-08A	*21*	*25*	*5.3*	**51.3**	<0.12	*1.2*	*0.47*	<0.12	<0.51	*1.2*	<1.4	<0.16	*1.8*
CS-GC-08B	*12*	*16*	*5.5*	**33.5**	<0.12	*1.0*	*0.55*	<0.12	<0.51	*0.78*	*2.9*	<0.16	*1.7*
Screen level (SL)	DDD + DDE + DDT =			**6.9**	10	10	*	*	*	*	*	*	*
Mean	6.4	9.2	0.9	**16.5**	0.94	0.18	0.04	0.04	0.14	0.07	1.18	0.01	0.26
Maximum	21	25	5.5	**51.3**	1.6	1.2	0.71	0.37	1.2	1.2	12	0.17	1.8

Values detected for DDT were confirmed with second column.

* SL has not been established.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 3. Preliminary Meandering Channel Design Summary						
Area	Location	Proposed Dredging	Dredge Volume (cubic yards)	Inwater Disposal?	Dredging Prism DDT (ug/kg)	Bottom of Core DDT (ug/kg)
1	MCDD #1 to Whitaker Slough	Dredge to elevation 0ft	N/A	Yes	2.1	ND
2	Whitaker Slough to 78th Avenue	Dredge to elevation 0ft	N/A	Yes	5.3	ND
	78th to 82nd Avenue	Dredge to elevation 2ft	N/A	Yes	5.3	ND
3	82nd Avenue to 92nd Avenue	Dredge to elevation 2ft	13,000	Yes	10.8	4.7
4	92nd Avenue to I-205	Dredge to elevation 2ft	38,000	Yes	14.4	3.0
	I-205 to 122nd Avenue					
	122nd Avenue to 138th Avenue					
5	138th Avenue to Mid-dike levee	Dredge to elevation 2ft	28,300	Yes	31	11.3
	Mid-dike levee to 148th Avenue	Dredge to elevation 3ft				
	148th Avenue to 158th Avenue	Dredge to elevation 2ft				
6	158th Avenue to Four Corners	None	N/A	No	14.9	7.1
7	Four Corners to MCDD #4	None	N/A	No	43	41.9
8	Four Corners to Bridge B	None	N/A	No	51.3	33.5
	Bridge B to Bridge C	Dredge to elevation 5ft	13,000	Yes	51.3	33.5
	Bridge C through vegetated area east of 185th Avenue bridge	None		No	51.3	33.5
	East of 185th Avenue to Fairview Lake	Dredge to elevation 5ft		Yes	51.3	33.5
ND = Not detected N/A = Non-Applicable						

Table 4. Summary of Acute and Chronic Bioassays									
Area	Sample	H. azteca	C. tentans				Initial Porewater NH3		
		% Survival	% Survival	Growth (mg)	% fines	% TOC	(mg N/L)	ΣDDT (ug/kg)	Organic Carbon (ug/g)
	Control	92.5 (0.016)	78.8 (0.058)	1.48 (0.011)	2	0.02	0.06	N.A.	N.A.
1	CS-HC-01R	40.0 (0.046)	73.8 (0.057)	0.89 (0.056)	44	1.2	4.2	6.1	0.5
3	CS-HC-02SSG	80.0 (0.053)	28.8 (0.130)	1.46 (0.285)	50	1.6	5.2	2.4	0.15
4	CS-HC-03SSG	65.0 (0.057)	66.3 (0.092)	1.00 (0.081)	65	1.6	3.3	2.7	0.17
5	CS-HC-04SSG	53.8 (0.053)	70.0 (0.073)	0.78 (0.084)	91	2.3	6.7	5.5	0.235
8	CS-HC-05SSG-B	26.3 (0.046)	63.8 (0.073)	0.33 (0.055)	65	2.7	9.4	9.8	0.365

Table 5: Summary of bioaccumulation test results and analysis for the Columbia Slough sediment CS-HC-05SSG-B.

Sample I.D.	DDT Metabolite	Method Detection Limit (µg/kg)	Mean Tissue Conc. (µg/kg)	Steady State adjusted Tissue Concentration[1]	Comments
Control	4,4'-DDD	1.0	<0.70	N.A.	
	4,4'-DDE	1.0	<0.46	N.A.	
	4,4'DDT	1.0	<0.59	N.A.	
Reference CS-HC-01R	4,4'-DDD	1.0	<0.65	N.A.	
	4,4'-DDE	1.0	2.5	4.2	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	0.48	0.8	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (mortality in the Dragonfly) is 14.4 µg/Kg
CS-HC-05SSG-B	4,4'-DDD	1.0	<0.77	N.A.	
	4,4'-DDE	1.0	0.1 (0.55 in one of 5 replicates)	0.29	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	<0.64	N.A	

[1]Steady-state tissue concentrations were estimated based on a log K_{ow} value of 5.7 (from table 9-5 of the ITM) for DDT and DDE and using the function for the expected proportion of steady state concentration at 28-days developed by McFarland (1994) (figure 6-1 in the ITM).

[Code of Federal Regulations]
[Title 40, Volume 17, Parts 190 to 259]
[Revised as of July 1, 1999]
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[Page 260-261]
TITLE 40--PROTECTION OF ENVIRONMENT AGENCY (CONTINUED)

PART 230--SECTION 404(b)(1) GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL--Table of Contents

Subpart G--Evaluation and Testing Sec.
230.60 General evaluation of dredged or fill material.

The purpose of these evaluation procedures and the chemical and biological testing sequence outlined in Sec. 230.61 is to provide information to reach the determinations required by Sec. 230.11. Where the results of prior evaluations, chemical and biological tests, scientific research, and experience can provide information helpful in making a determination, these should be used. Such prior results may make new testing unnecessary. The information used shall be documented. Where the same information applies to more than one determination, it may be documented once and referenced in later determinations.

(a) If the evaluation under paragraph (b) indicates the dredged or fill material is not a carrier of contaminants, then the required determinations pertaining to the presence and effects of contaminants can be made without testing. Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material. Dredged material so composed is generally found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels. However, when such material is discolored or contains other indications that contaminants may be present, further inquiry should be made.

(b) The extraction site shall be examined in order to assess whether it is sufficiently removed from sources of pollution to provide reasonable assurance that the proposed discharge material is not a carrier of contaminants. Factors to be considered include but are not limited to:

(1) Potential routes of contaminants or contaminated sediments to the extraction site, based on hydrographic or other maps, aerial photography, or other materials that show watercourses, surface relief, proximity to tidal movement, private and public roads, location of buildings, municipal and industrial areas, and agricultural or forest lands.

(2) Pertinent results from tests previously carried out on the material at the extraction site, or carried out on similar material for other permitted projects in the vicinity. Materials shall be considered similar if the sources of contamination, the physical configuration of the sites and the sediment composition of the materials are comparable, in light of water circulation and stratification, sediment accumulation and general sediment characteristics. Tests from other sites may be relied on only if no changes have occurred at the extraction sites to render the results irrelevant.

(3) Any potential for significant introduction of persistent pesticides from land runoff or percolation;

(4) Any records of spills or disposal of petroleum products or substances designated as hazardous under section 311 of the Clean Water Act (See 40 CFR part 116);

(5) Information in Federal, State and local records indicating significant introduction of pollutants from industries, municipalities, or other sources, including types and amounts of waste materials discharged along the potential routes of contaminants to the extraction site; and

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(6) Any possibility of the presence of substantial natural deposits of minerals or other substances which could be released to the aquatic environment in harmful quantities by man-induced discharge activities.

(c) To reach the determinations in Sec. 230.11 involving potential effects of the discharge on the characteristics of the disposal site, the narrative guidance in subparts C through F shall be used along with the general evaluation procedure in Sec. 230.60 and, if necessary, the chemical and biological testing sequence in Sec. 230.61. Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing will not be required.

(d) Even if the Sec. 230.60(b) evaluation (previous tests, the presence of polluting industries and information about their discharge or runoff into waters of the U.S., bioinventories, etc.) leads to the conclusion that there is a high probability that the material proposed for discharge is a carrier of contaminants, testing may not be necessary if constraints are available to reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site, if such constraints are acceptable to the permitting authority and the Regional Administrator, and if the potential discharger is willing and able to implement such constraints. However, even if tests are not performed, the permitting authority must still determine the probable impact of the operation on the receiving aquatic ecosystem. Any decision not to test must be explained in the determinations made under Sec. 230.11.

[Code of Federal Regulations]
[Title 40, Volume 17, Parts 190 to 259]
[Revised as of July 1, 1999]
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[Page 250-252]

TITLE 40--PROTECTION OF ENVIRONMENT AGENCY (CONTINUED)

PART 230--SECTION 404(b)(1) GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL--Table of Contents

Subpart B--Compliance With the Guidelines

Sec. 230.11 Factual determinations.

The permitting authority shall determine in writing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment in light of subparts C through F. Such factual determinations shall be used in Sec. 230.12 in making findings of compliance or non-compliance with the restrictions on discharge in Sec. 230.10. The evaluation and testing procedures described in Sec. 230.60 and Sec. 230.61 of subpart G shall be used as necessary to make, and shall be described in, such determination. The determinations of effects of each proposed discharge shall include the following:

(a) Physical substrate determinations. Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, on the characteristics of the substrate at the proposed disposal site. Consideration shall be given to the similarity in particle size, shape, and degree of compaction of the material proposed for discharge and the material constituting the substrate at the disposal site, and any potential changes in substrate elevation and bottom contours, including changes outside of the disposal site which may occur as a result of erosion, slumpage, or other movement of the discharged material. The duration and physical extent of substrate changes shall also be considered. The possible loss of environmental values (Sec. 230.20) and actions to minimize impact (subpart H) shall also be considered in making these determinations. Potential changes in substrate elevation and bottom contours shall be predicted on the basis of the proposed method, volume, location, and rate of discharge, as well as on the individual and combined effects of current patterns, water circulation, wind and wave action, and other physical factors that may affect the movement of the discharged material.

(b) Water circulation, fluctuation, and salinity determinations. Determine the nature and degree of effect that the proposed discharge will have individually and cumulatively on water, current patterns, circulation including downstream flows, and normal water fluctuation. Consideration shall be given to water chemistry, salinity, clarity, color, odor, taste, dissolved gas levels, temperature, nutrients, and eutrophication plus other appropriate characteristics. Consideration shall also be given to the potential diversion or obstruction of flow, alterations of bottom contours, or other significant changes in the hydrologic regime. Additional consideration of the possible loss of environmental values (Secs. 230.23 through 230.25) and actions to minimize impacts (subpart H), shall be used in

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making these determinations. Potential significant effects on the current patterns, water circulation, normal water fluctuation and salinity shall be evaluated on the basis of the proposed method, volume, location, and rate of discharge.

(c) Suspended particulate/turbidity determinations. Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, in terms of potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site. Consideration shall be given to the grain size of the material proposed for discharge, the shape and size of the plume of suspended particulates, the duration of the discharge and resulting plume and whether or not the potential changes will cause violations of applicable water quality standards. Consideration should also be given to the possible loss of environmental values (Sec. 230.21) and to actions for minimizing impacts (subpart H). Consideration shall include the proposed method, volume, location, and rate of discharge, as well as the individual and combined effects of current patterns, water circulation and fluctuations, wind and wave action, and other physical factors on the movement of suspended particulates.

(d) Contaminant determinations. Determine the degree to which the material proposed for discharge will introduce, relocate, or increase contaminants. This determination shall consider the material to be discharged, the aquatic environment at the proposed disposal site, and the availability of contaminants.

(e) Aquatic ecosystem and organism determinations. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms. Consideration shall be given to the effect at the proposed disposal site of potential changes in substrate characteristics and elevation, water or substrate chemistry, nutrients, currents, circulation, fluctuation, and salinity, on the recolonization and existence of indigenous aquatic organisms or communities. Possible loss of environmental values (Sec. 230.31), and actions to minimize impacts (subpart H) shall be examined. Tests as described in Sec. 230.61 (Evaluation and Testing), may be required to provide information on the effect of the discharge material on communities or populations of organisms expected to be exposed to it.

(f) Proposed disposal site determinations. (1) Each disposal site shall be specified through the application of these Guidelines. The mixing zone shall be confined to the smallest practicable zone within each specified disposal site that is consistent with the type of dispersion determined to be appropriate by the application of these Guidelines. In a few special cases under unique environmental conditions, where there is adequate justification to show that widespread dispersion by natural means will result in no significantly adverse environmental effects, the discharged material may be intended to be spread naturally in a very thin layer over a large area of the substrate rather than be contained within the disposal site.

(2) The permitting authority and the Regional Administrator shall consider the following factors in determining the acceptability of a proposed mixing zone:

(i) Depth of water at the disposal site;

(ii) Current velocity, direction, and variability at the disposal site;

(iii) Degree of turbulence;

(iv) Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site;

(v) Discharge vessel speed and direction, if appropriate;

(vi) Rate of discharge;

(vii) Ambient concentration of constituents of interest;

(viii) Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities;

(ix) Number of discharge actions per unit of time;

(x) Other factors of the disposal site that affect the rates and patterns of mixing.

(g) Determination of cumulative effects on the aquatic ecosystem.

(1) Cumulative impacts are the changes in an aquatic

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ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.

(2) Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit applications, the issuance of a General permit, and monitoring and enforcement of existing permits.

(h) Determination of secondary effects on the aquatic ecosystem.

(1) Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final section 404 action is taken by permitting authorities.

(2) Some examples of secondary effects on an aquatic ecosystem are fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the U.S. Activities to be conducted on fast land created by the discharge of dredged or fill material in waters of the United States may have secondary impacts within those waters which should be considered in evaluating the impact of creating those fast lands.

Draft

Columbia Slough
Sediment Quality Evaluation
Sampled May 18-19 & Oct 6, 1999

Abstract

The Clean Water Act (CWA) of 1977, as amended regulates dredging activities and requires sediment quality evaluation, including testing, prior to dredging. Guidelines to implement 40 CFR Part 230-Section 404(b)(1) regulations of the CWA, the national Inland Testing Manual (ITM) and the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF) have adopted a tiered testing approach for the evaluation of dredge material. The Tier IIa (physical testing), Tier IIb (chemical testing) and Tier III (biological testing) have been completed for this evaluation. The screening levels (SL) used are those adopted in the regional DMEF manual.

For the May 18-19, 1999 sampling event the US Army Corps of Engineers, Portland District personnel with operator and boat supplied by Multnomah County Drainage District, collected 22 gravity core samples from the Upper Channel of Columbia Slough. The approximately 10-mile long study area of the upper channel of the slough was divided into 8 sampling areas. Samples collected in each area were composited and each divided, with the top representing the dredging prism and the bottom of the core representing the "newly exposed surface" after dredging is completed. The gravity corer penetrated the sediment from 3'- 5', with retained core lengths from 2.5' to 4.5'. With few exceptions, the newly exposed surface is cleaner than the material to be dredged. The pesticide DDT (DDD+DDE+DDT) was, the only chemical of concern (COC), found in excess (7.1 to 51.3 ug/kg) of the 6.9 ug/kg SL in 10 out of 16 analyses.

Tier III biological samples were collected from the areas where DDT exceeded the SLs. Figure 2 shows areas where individual samples were collected and composited. Freshwater bioassays were analyzed for 10-day survival (*Hyalella a.*), 10-day survival and growth (*Chironomus t.)* and 28-day tissue residue (*Limbriculus v.*). The results of the biological tests did not give a clear indication which sediments were acceptable for in-water disposal. The DMEF established the Dredge Material Management Team (DMMT) to apply "best professional judgement" in making decisions on the fate of sediments where testing does not provide clear-cut answers. The DMMT will be consulted to make the final determination for the fate of the sediment in question. (See Attachment C for the Multnomah County Drainage District's (MCDD) proposal to the DMMT). (See the main Columbia Slough Report for final determination of DMMT).

Introduction

The purpose of this report is to characterize the sediment of portions of the Columbia Slough Upper Channel for the purpose of meandering channel creation based on the sampling event described. Objectives from the sampling and analysis plan are listed below. This report will outline the procedures used to accomplish these goals.

Draft

SAMPLING AND ANALYSIS OBJECTIVES

The sediment characterization program objectives and constraints are summarized below:

To characterize sediments in accordance with the regional dredge material testing manual, the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (Nov. 1998) (DMEF).

Collect, handle and analyze representative sediment, of the purposed dredging prism, in accordance with protocols and Quality Assurance/Quality Control (QA/QC) requirements. Characterize sediments to be dredged for evaluation of environmental impact.

Conducted physical, chemical and biological (if needed) characterization of sediment to be dredged.

Historical Data

Numerous surface samples have been taken in the Upper Channel of the slough on various dates and locations. Most of the analyses were below the SLs of the DMEF. Those analyses exceeding the SLs were 4 heavy metals (Cd, Pb, Zn, and Hg), 3 phenol groups, 2 phthalate groups, 1 alcohol and 1 pesticide.

Table 1, Contaminates Found on Previous Sampling Events - (exceeding SL)

Area	Cd	Pb	Zn	Hg	Total DDT	4-methyl phenol	2,4-Dimethyl phenol	2-Methyl phenol	Bis (2ethylhexy) phthalate	Butyl benzyl phthalate	Benzyl Alcohol	Dieldrin
	Mg/kg (ppm)				Ug/kg (ppb)							
1					12.3			3300				
					8.5			3100				
					12.2							
					9							
					15.6							
					13.1							
					13.8							
2					24.3						65	
					17.2							
					9.4							
					23							
					44.1							
					9.1							
					17.7							
					25.8							
					7.4							
					7.1							
					9.8							
3					18.4	1400						
					9.2							
4					19	1200	1000	460			1300	
					15.5	880						
					15	800						

					17.5 9.2 8 27.9 17.9 23.1							
5		510	722									
6	36 84	510 520	132 0 131 0	.51	13.7 36.2 9.3				11000 38000 40000 31000 59000 32000	1100		
7					9.3							
8					9.9 16.6	790			16000			20 20
SL	5.1	450	410	0.41	6.9	670	29	670	8300	970	57	10

Current Sampling Event

The US Army Corps of Engineers, Portland District personnel with operator and boat supplied by Multnomah County Drainage District, collected gravity core samples from the Upper Channel of Columbia Slough on May 18-19, 1999. The Upper Channel study area was divided into 8 sampling areas (see figure 1). The approximately 10-mile long study area of the upper channel of the slough was divided into 8 sampling areas. Samples collected in each area were composited and each divided, with the top representing the dredging prism and the bottom of the core representing the "newly exposed surface" after dredging is completed. The gravity corer penetrated the sediment from 3'- 5', with retained core lengths from 2.5' to 4.5'. With few exceptions, the newly exposed surface is cleaner than the material to be dredged. The pesticide DDT (DDD+DDE+DDT) was, the only COC, found in excess (7.1 to 51.3 ug/kg) of the 6.9 ug/kg SL in 10 out of 16 analyses. The eight composite core samples were divided, with the top representing the dredging prism and the bottom 6" to 12", representing the "newly exposed surface" after dredging is completed.

On October 6, 1999 one (1) composite reference and 4 composite samples were submitted for Tier III biological analysis from the areas where DDT exceeded the SLs. Figure 2 shows areas where individual samples were collected and composited. These samples were analyzed for 10-day survival (*Hyalella a.*), 10-day survival and growth (*Chironomus t.)* and 28-day tissue residue (*Limbriculus v.*).

Results/Discussion

<u>Physical and Volatile Solids</u>: Data for the May 18-19, 1999 physical analyses are presented in Table 2. All samples submitted for analysis exceeded 20% fines with 7 of 16 exceeding 5% volatile solids. Four (4) samples submitted were classified as "silty sand", with 12 samples classified as "silt". Median grain size for all samples is 0.05 mm, with 38.2 % sand and 61.1% fines. All samples were dark brown to dark gray in color with very little odor and no sheen. Nine (9) samples contained wood chips.

Data for the October 6, 1999 physical analyses are presented in Table 3. All samples submitted for analysis exceeded 20% fines with 2 of 5 exceeding 5% volatile solids. All 5 samples collected were classified as "silt". Median grain size for all samples is 0.05 mm, with 37.6 % sand and 62.4% fines. All samples were dark brown to dark gray in color with very little odor and no sheen. All samples contained wood chips.

Metals and Total Organic Carbon (TOC): Data for the May 18-19, 1999 analyses are presented in Table 4. Low levels of some metals were found in most of the samples collected, but levels do not approach the SL. The highest level detected was for mercury, which is 75.7% of the SL. Cadmium was the next highest level detected in a metal, at 45.1% of the SL. Total Organic Carbon values ranged from 5800 to 33000 mg/kg.

Pesticide/PCBs, Phenols, Phthalates and Misc. Extractables: Data for the May 18-19, 1999 analyses are presented in Table 5 & 7. No PCBs were found at the method detection limits. Total DDT was found in all but 2 samples, with 10 of 16 exceeding the 6.9 ug/kg SL. Only 1 sample (CS-GC-08A) exceeded the bioaccumulation trigger of 50 ug/kg. Three phenols were detected at low levels (highest 27.5% of SL). Five (5) phthalates were detected at low levels (highest 13.4% of SL). Benzoic Acid and Benzyl Alcohol were found in 2 of the 16 samples at low levels (highest 1.3% of SL). Dibenzofuran was detected in 11 of 16 samples (highest 56.9% of SL).

Data for the October 6, 1999 DDT Sediment analyses are presented in Table 6. DDT or its breakdown components were detected in all samples, with only sample CS-HC-05SSG-B (from area 8) exceeding the screening level, at 8.9 ug/kg.

Data for the October 6, 1999 DDT Tissue analyses are presented in Table 6. No DDT was detected in the Control sample at the method detection limit. DDT was detected in the reference sample in all five replicates, ranging from 0.9 to 4.4 ug/kg. The only sample submitted for bioaccumulation analysis was CS-HC-05SSG-B. One (1) of 5 replicates indicated bioaccumulation above the method detection limit at 0.55 ug/kg.

Polynuclear Aromatic Hydrocarbons (PAHs): Data for the May 18-19, 1999 sample analyses are presented in Tables 8 & 9 (PAHs were not run on the Oct. 6, 1999 sediment samples). Low levels of some individual "low molecular weight" PAHs were found in all samples, highest is 24% of SL. Most of the "high molecular weight" PAHs were found in all samples, highest is 68.7% of SL.

Bioassay/Bioaccumulation: Data for the October 6, 1999 samples analyses are presented in Attachment A and B (MEC laboratory reports and evaluations).

The results of the Bioassay samples indicated no bioaccumulation for DDT in the sample tested (CS-HC-05SSG-B, Area 8) (See Attachment B). The lowest acceptable survival for *Hyalella* in reference sediment is 70%. The survival in the test reference was 40%; this constitutes a failure in the reference. A 15% mortality rate less than the reference is allowable for the test sediment. If the reference were at the minimum acceptable level of 70%, the lowest test sediment level would be 59.5%. At this lowest allowable reference level, samples CS-HC-04SSG and CS-HC-

05SSG-B would fail the 15% less than reference requirement, at 53.8 and 26.3 respectively. The Chironomus test results indicate sample CS-HC-02SSG failed the survival at 28.8% and was statistically different. Sample CS-HC-05SSG-B failed the growth test with a mean reduction in biomass greater than 40% and has statistically significant difference.

Conclusion

Collection and evaluation of the sediment data was completed using guidelines from both the Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF) and the Inland Testing Manual (ITM). The DMEF is a regional manual developed jointly with regional EPA, Corps, Oregon Dept. of Environmental Quality and Washington Depts. of Ecology and Natural Resources. The ITM is a national manual developed jointly by EPA and Corps for dredge material evaluation. These documents are guidelines for implementing the Clean Water Act, 40 CFR 230 sec 404 (b)(1).

The screening levels used are those adopted for use in the DMEF. The DMEF Tiered testing approach requires that material in excess of 20% fines and greater than 5% volatile solids, as well as any material with prior history or is suspected ("reason to believe") of being contaminated, be subjected to chemical as well as physical analyses. Under the Tiered approach, if the chemical analytical results do not exceed the established screening levels (SL), the material is suitable for unconfined in-water disposal. If the material represented by the Tier IIb chemical samples exceeds the established SLs, the material must be subjected to Tier III, bioassay analyses.

The DMEF states that in a freshwater bioassay the control and reference have performance standards that must be met, depending on the bioassay test performed and all results must be statistically significant.

For the amphipod (*Hyalella a.*) bioassay a performance standard of 20% absolute mean mortality is set for the control sample. The reference must have a performance standard of 30% absolute mean mortality. The test sediment must have a mean test mortality no more than 15% below reference response.

The midge (*Chironomus t.*) bioassay control must have a performance standard of 30% absolute mean mortality and a growth performance standard of 0.6 mg minimum mean weight per organism. The reference must have a performance standard of 35% absolute mean mortality. The test sediment must have a mean test mortality no more than 20% below reference response, for the growth test the mean reduction in biomass can be no greater than 40%.

The Tier IIb, chemical, analyses indicated exceedances of DMEF screening levels for total DDT (see table 5) in 10 of 16 analysis, with the bioaccumulation trigger of 50 ug/kg exceeded in 1 sample (CS-GC-08A, Area 8). Bioassay samples were collected from the areas that exceeded SLs on October 6, 1999. The results of the Bioassay samples indicated no bioaccumulation for DDT in the sample tested (CS-HC-05SSG-B, Area 8) (See Attachment B). The lowest acceptable survival for *Hyalella* in reference sediment is 70%. The survival in the test reference was 40%; this constitutes a failure in the reference. A 15% mortality rate less than the reference is allowable for the test sediment. If the reference were at the minimum acceptable level of 70%, the lowest test sediment level would be 55%. At this lowest allowable reference level, samples CS-HC-04SSG and CS-HC-05SSG-B would fail the 15% less than reference requirement, at 53.8 and 26.3 respectively. The Chironomus test results indicate sample CS-HC-02SSG failed the survival at 28.8% and was statistically different. Sample CS-HC-05SSG-B failed the growth test with a mean reduction in biomass greater than 40% and has statistically significant difference.

These results were presented to the Dredge Material Management Team (DMMT) on February 16, 2000 (See Attachment C for presentation). The DMMT's interpretation of the results will be forthcoming. The DMMT's initial interpretation, at the presentation, indicated areas where sediment failed bioaccumulation would require upland disposal, without return water to the slough. The DDT levels in sediment to be place upland would not pose human health concerns.

References

U.S. army Corps of Engineers, Portland District, Seattle District; U.S. Environmental Protection Agency, Region 10; Oregon Department of Environmental Quality; Washington State Department of Natural Resources and Department of Ecology. 1998 Final. Dredge Material Evaluation Framework for the Lower Columbia River Management Area.

U. S. Environmental Protection Agency and U. S. Army Corps of Engineers. February 1998. Evaluation of Dredged Material Proposed for Discharge in Inland and Near Coastal Waters – Testing Manual, dated (referred to as the "Inland Testing Manual").

The Clean Water Act, 40 CFR 230 (b) (1).

Physical Analysis

	Grain Size (mm)		%			
Sample I.D.	Median	Mean	Gravel	Sand	Silt/Clay	Volatile solids
CS-GC-01A	0.07	0.07	0.10	59.3	40.5	4.61
CS-GC-01B	0.05	0.03	0.00	28.3	71.6	5.05
CS-GC-02A	0.06	0.07	0.24	45.1	54.7	3.78
CS-GC-02B	0.05	0.04	0.05	33.97	65.99	4.17
CS-GC-03A	0.07	0.06	0.00	56.3	43.7	4.33
CS-GC-03B	0.06	0.04	0.00	47.66	52.34	2.79
CS-GC-04A	0.06	0.06	0.01	50.76	49.23	4.70
CS-GC-04B	0.05	0.08	0.50	76.60	23.10	5.60
CS-GC-05A	0.04	0.08	0.00	35.66	64.34	5.96
CS-GC-05B	0.04	0.04	0.00	23.33	76.67	4.91
CS-GC-06A	0.04	0.09	0.00	28.87	71.12	5.20
CS-GC-06B	0.08	0.03	0.41	32.77	66.82	3.26
CS-GC-07A	0.03	0.06	0.00	17.27	82.73	7.73
CS-GC-07B	0.03	0.01	0.00	8.05	91.95	7.93
CS-GC-08A	0.06	0.07	0.00	34.65	65.35	9.80
CS-GC-08B	0.05	0.81	7.74	32.15	60.12	5.96
CS-GC-08B (lab dup.)	0.05	0.66	9.36	32.49	56.15	6.18
Mean	0.05	0.09	0.62	38.18	61.14	5.37
Minimum	0.03	0.01	0.00	8.05	23.10	2.79
Maximum	0.08	0.81	9.36	76.60	82.73	9.80

Physical Analysis

	Grain Size (mm)				%			
Sample I.D.	Median		Mean		Gravel	Sand	Silt/Clay	Volatile solids
CS-HC-01R (reference sample)	0.08		0.05		0.0	61.4	38.6	4.35
CS-GC-02SSG	0.06		0.06		0.0	46.8	53.2	4.92
CS-GC-03SSG	0.05		0.05		0.0	38.1	61.9	4.76
CS-GC-04SSG	0.02		0.04		0.0	13.8	86.2	7.00
CS-GC-05SSG-B	0.04		0.05		0.0	29.4	70.6	6.53
CS-GC-05SSG-B (lab duplicate)	0.02		0.05		0.0	26.2	73.8	7.07
Mean	0.05		0.05		0.0	37.6	62.4	5.57
Minimum	0.02		0.04		0.0	13.8	38.6	4.35
Maximum	0.08		0.06		0.0	61.4	86.2	7.07

Inorganic Metals and Total Organic Carbon

Sample I.D.	As	Sb	Cd	Cu	Pb	Hg	Ni	Ag	Zn	TOC
	mg/kg (ppm)									
CS-GC-01A	3.3	<70	1	33	<11	<.11	13	0.61	110	13000
CS-A (DUP -01A)	3.7	<70	0.74	23	<11	<.11	18	0.29	120	14000
CS-GC-01B	6	<70	0.75	38	<11	<.11	17	0.67	110	13000
CS-GC-02A	3.3	<70	0.49	29	<11	<.11	17	0.39	73	8400
CS-GC-02B	2.1	<70	0.29	29	<11	<.11	17	0.34	59	8600
CS-GC-03A	2.8	<70	0.79	31	<11	<.11	16	0.44	99	15000
CS-GC-03B	2.2	<70	0.47	24	<11	<.11	13	0.27	72	5800
CS-GC-04A	3.1	<70	0.77	30	<11	<.11	23	0.39	130	16000
CS-GC-04B	2	<70	0.4	22	<11	<.11	11	0.27	61	11000
CS-GC-05A	3.8	<70	1.1	53	42	0.31	26	0.41	130	21000
CS-GC-05B	2.8	<70	0.6	45	<11	<.11	18	0.39	79	16000
CS-GC-06A	3.8	<70	0.71	29	<11	<.11	17	0.5	110	15000
CS-GC-06B	2.6	<70	0.33	29	<11	<.11	13	0.35	70	7400
CS-GC-07A	4.3	<70	1.1	43	55	0.16	23	0.54	160	27000
CS-GC-07B	4.9	<70	2.3	38	24	0.21	17	0.59	130	22000
CS-GC-08A	3.1	<70	1.3	38	37	<.11	19	0.53	170	33000
CS-GC-08B	3.6	<70	0.82	33	51	<.11	23	0.49	140	21000
Screening level (SL)	57	150	5.1	390	450	0.41	140	6.1	410	
Mean	3.4	ND	0.82	33.35	12.29	0.04	17.7	0.44	107.2	
Maximum	6.0	ND	2.3	53	55	0.31	26	0.67	170	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 5, Columbia Slough GI Study **Sampled May 18-19, 1999**

Pesticides/PCBs

Sample I.D.	Pesticides ug/kg (ppb)												
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Aldrin	Dieldrin	Alpha-BHC	Delta-BHC	Endosulfan 1	Endrin	Endrin aldehyde	Hepta chlor	Hepta chlor epoxide
CS-GC-01A	<0.58	2.1	<2.0	2.1	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-A (DUP-01A)	1.8	3.5	<2.0	5.2	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-01B	<0.33	<0.69	<2.4	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02A	2.8	2.5	<1.8	5.3	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02B	<0.26	<0.54	<1.9	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03A	**4.3**	**6.5**	<2.2	**10.8**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03B	1.9	2.8	<1.8	4.7	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-04A	**5.5**	**8.9**	<2.1	**14.4**	<0.12	<0.11	<0.12	<0.12	*1.2*	<0.19	*12*	<0.16	<0.26
CS-GC-04B	1.7	1.3	<1.7	3.0	<0.12	<0.11	<0.12	*0.37*	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-05A	**14**	**17**	<2.4	**31.0**	*1.6*	*0.94*	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	*0.46*
CS-GC-05B	**3.9**	**7.4**	<2.1	**11.3**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-06A	**6.3**	**8.6**	<2.4	**14.9**	<0.12	<0.11	*0.39*	<0.12	*0.72*	<0.19	<1.4	<0.16	<0.26
CS-GC-06B	**2.8**	**4.3**	<1.7	**7.1**	<0.12	<0.11	<0.12	*0.24*	<0.51	<0.19	<1.4	*0.17*	<0.26
CS-GC-07A	**14**	**29**	<3.2	**43.0**	<0.12	<0.11	*0.71*	<0.12	<0.51	<0.19	*5.1*	<0.16	*0.58*
CS-GC-07B	**16**	**22**	**3.9**	**41.9**	<0.12	<0.11	<0.12	<0.12	*1.1*	<0.19	<1.4	<0.16	<0.26
CS-GC-08A	**21**	**25**	**5.3**	**51.3**	<0.12	*1.2*	*0.47*	<0.12	<0.51	*1.2*	<1.4	<0.16	*1.8*
CS-GC-08B	**12**	**16**	**5.5**	**33.5**	<0.12	*1.0*	*0.55*	<0.12	<0.51	*0.78*	*2.9*	<0.16	*1.7*
Screen level (SL)	DDD + DDE + DDT =			6.9	10	10	*	*	*	*	*	*	*
Mean	6.4	9.2	0.9	16.5	0.94	0.18	0.04	0.04	0.14	0.07	1.18	0.01	0.26
Maximum	21	25	5.5	51.3	1.6	1.2	0.71	0.37	1.2	1.2	12	0.17	1.8

Values detected for DDT were confirmed with second column.

PCBs = Non-detect (ND) <19.0 ppb (SL = 130 ppb).

* SL has not been established.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Table 6, Columbia Slough GI Study

Sampled Oct 6, 1999

Tier III
DDT Sediment Analysis

Sample I.D.				
	ug/kg (ppb)			
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT
CS-HC-01R	1.5	2.5	2.1	6.1
CS-HC-02SSG	<0.6	2.4	<2.1	2.4
CS-HC-03SSG	<0.28	2.7	<2.1	2.7
CS-HC-04SSG	2.1	3.4	<2.8	5.5
CS-HC-05SSG-B	**4.3**	**5.5**	<2.1	**8.9**
Screening Level	DDD +	DDE +	DDT +	= 6.9

* Aroclor 1260 was detected at 23 ug/kg (SL = 130) & Endrin was detected at 3.5 ug/kg (no SL) in sample CS-HC-05SSG-B.

Tier III
DDT Tissue Analysis

Sample I.D.					Sample I.D.					Sample I.D.				
	ug/kg (ppb)													
	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT		4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT		4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT
Control					CS-HC-01R Reference					CS-HC-05 SSG-B				
Rep - 1	<0.77	<0.51	<0.65	ND	Rep - 1	<0.59	4.4	<0.50	4.4	Rep - 1	<0.98	<0.65	<0.82	ND
Rep - 2	<0.83	<0.55	<0.69	ND	Rep - 2	<0.82	1.0	1.0	2.0	Rep - 2	<0.69	<0.49	<0.58	ND
Rep - 3	<0.71	<0.47	<0.59	ND	Rep - 3	<0.59	0.9	<0.49	0.9	Rep - 3	<0.59	0.55	<0.49	0.55
Rep - 4	<0.61	<0.40	<0.51	ND	Rep - 4	<0.69	3.7	<0.58	3.7	Rep - 4	<0.79	<0.53	<0.66	ND
Rep - 5	<0.59	<0.39	<0.49	ND	Rep – 5	<0.58	2.5	1.4	3.9	Rep - 5	<0.79	<0.52	<0.66	ND
Mean				ND			2.5	0.48	2.98			0.11		0.11

Values detected for DDT were confirmed with second column.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Phenols, Phthalates and Extractables

Sample I.D.	Phenols			Phthalates					Extractables		
	ug/kg (ppb)										
	Penta chloro phenol	3-&4-Methyl phenol	Phenol	bis(2-Ethylhexzyl phthalate	Dimethyl phthalate	Di-n-butyl phthalate	Diethyl phthalate	Butylbenzyl phthalate	Dibenzo furan	Benzoic Acid	Benzyl Alcohol
CS-GC-01A	110	4.8	<9.7	130	4	21	33	<11	<2.9	23	<4.3
CS-A (DUP--01A)	<1.9	3.3	<9.7	59	11	11	14	28	<2.9	26	<4.3
CS-GC-01B	90	8.9	23	6.9	<13	7.9	7.9	<11	<2.9	<7.1	<4.3
CS-GC-02A	41	<1.6	<9.7	23	<13	9.2	22	<11	<2.9	<7.1	<4.3
CS-GC-02B	48	<1.6	14	18	<13	14	34	<11	<2.9	13	<4.3
CS-GC-03A	75	25	17	210	2.7	11	<4.7	14	<2.9	210	4.3
CS-GC-03B	44	3.5	7.8	28	<13	4.7	<4.7	<11	<2.9	370	<4.3
CS-GC-04A	61	3.9	<9.7	310	3.4	40	24	130	<2.9	19	<4.3
CS-GC-04B	34	3.7	10	11	<13	10	14	<11	<2.9	120	4.6
CS-GC-05A	<1.9	<1.6	<9.7	710	14	460	80	<11	7.2	<7.1	<4.3
CS-GC-05B	<1.9	<1.6	<9.7	210	<13	29	11	<11	<2.9	<7.1	<4.3
CS-GC-06A	<1.9	7.7	<9.7	190	3.2	39	29	15	<2.9	16	<4.3
CS-GC-06B	<1.9	<1.6	<9.7	29	<13	29	9	<11	<2.9	12	<4.3
CS-GC-07A	74	<1.6	<9.7	230	3.7	12	<4.7	<11	4.7	16	<4.3
CS-GC-07B	<1.9	<1.6	<9.7	200	<13	<3.5	<4.7	<11	<2.9	8.7	<4.3
CS-GC-08A	<1.9	7.2	<9.7	480	7.5	110	56	<11	<2.9	56	<4.3
CS-GC-08B	<1.9	<1.6	<9.7	230	4.4	25	11	<11	<2.9	<7.1	<4.3
Screen level (SL)	400	670	420	8300	1400	5100	1200	970	540	650	540
Mean	33.9	4	4.2	180.9	3.2	49	20.3	11	0.7	52.3	0.52
Maximum	110	25	23	710	14	460	80	130	7.2	370	4.6

Values detected for DDT were confirmed with second column.

PCBs = Non-detect (ND) <18.0 ppb (SL = 130 ppb).

Chlorinated Herbicides (Method 8151) = Non-detect (ND) <19.0 ppb, (SL has not been set).

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

Low Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Acenapththene	Acenaphthylene	Anthracene	Fluorene	2-Methyl napthalene	Naphthalene	Phenanthrene	Total Low PAHs
CS-GC-01A	3.3	9.4	7.5	4.4	3.1	7.7	35	70.4
CS-A(DUP-01A)	<1.9	10	7.5	<2.4	<2.3	3.5	32	53
CS-GC-01B	<1.9	13	4.6	<2.4	<2.3	<2.0	19	36.6
CS-GC-02A	11	<2.3	4.5	<2.4	<2.3	<2.0	16	31.5
CS-GC-02B	<1.9	<2.3	<2.3	<2.4	<2.3	<2.0	3.4	3.4
CS-GC-03A	<1.9	9.6	5.9	<2.4	<2.3	3.4	26	44.9
CS-GC-03B	<1.9	<2.4	<2.3	<2.4	<2.3	<2.0	6.5	6.5
CS-GC-04A	<1.9	<2.4	3	<2.4	<2.3	<2.0	9.6	12.6
CS-GC-04B	<1.9	<2.4	<2.3	<2.4	<2.3	<2.0	2.3	2.3
CS-GC-05A	9.3	<2.4	22	23	<2.3	<2.0	61	115.3
CS-GC-05B	<1.9	5	4.1	4.3	<2.3	<2.0	13	26.4
CS-GC-06A	14	130	82	14	<2.3	5.6	360	605.6
CS-GC-06B	<1.9	4.3	<2.3	<2.4	<2.3	<2.0	8	12.3
CS-GC-07A	6.1	11	14	9.4	3.7	18	59	121.2
CS-GC-07B	<1.9	3.6	<2.3	3.6	<2.3	<2.0	13	20.2
CS-GC-08A	5.7	8.8	15	9.1	5.3	7.9	47	98.8
CS-GC-08B	3.6	4.1	9.3	4.4	<2.3	3.3	55	79.7
Screen level (SL)	500	560	960	540	670	2100	1500	29000
Mean	3.1	12.3	0.24	4.2	0.7	2.9	45	
Maximum	11	130	82	23	5.3	18	360	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Polynuclear Aromatic Hydrocarbons (PAHs)

High Molecular Weight Analytes

ug/kg (ppb)

Sample I.D.	Benzo(a)anthracene	Benzo(b) fluroanthene	Benzo(k)fluroanthene	Benzo(g,h,i)perylene	Chrysene	Pyrene	Benzo(a) pyrene	Dibenz(a,h) anthracene	Indeno (1,2,3-cd) pyrene	Fluoranthene	Total High PAHs
CS-GC-01A	30	8.8	38	46	59	110	45	<2.2	40	81	457.8
CS-A(DUP-01A)	17	260	88	<2.1	24	63	<2.1	<2.1	<2.1	58	510
CS-GC-01B	9.9	<2.5	11	25	20	48	18	<2.5	15	42	188.9
CS-GC-02A	16	18	9.9	25	19	45	7.3	<1.9	14	46	200.2
CS-GC-02B	<2.1	<2.1	<2.1	<2.1	<2.1	5.2	<2.1	<2.1	2.5	5	12.7
CS-GC-03A	20	37	15	32	34	72	24	<2.3	22	64	320
CS-GC-03B	5.2	14	6.6	9.7	11	15	<1.9	<1.9	8	18	87.5
CS-GC-04A	11	21	6.6	16	19	29	11	<2.3	10	27	150.6
CS-GC-04B	4.1	<1.9	<1.9	4.3	<1.9	19	<1.9	<1.9	<1.9	23	50.4
CS-GC-05A	56	70	31	62	91	130	93	<2.6	45	150	728
CS-GC-05B	14	<2.0	<2.0	<2.0	10	29	24	<2.6	<2.0	28	105
CS-GC-06A	370	440	120	460	490	1300	540	<2.6	300	1100	5120
CS-GC-06B	3.5	10	2.9	9.2	5.1	13	10	<2.0	6.4	18	78.1
CS-GC-07A	28	31	12	42	35	57	36	<3.4	30	99	370
CS-GC-07B	6.6	<3.0	<3.0	14	11	31	<3.0	<3.0	<3.0	27	89.6
CS-GC-08A	47	<3.1	<3.1	48	84	110	57	<3.1	27	120	493
CS-GC-08B	35	47	16	28	58	97	<2.6	<2.6	<2.6	120	401
Screen level (SL)	1300	3200		670	1400	2600	1600	230	600	1700	12000
Mean	39.6	77.3		48.3	57.1	127.8	50.9	ND	30.5	119.2	
Maximum	370	560		460	490	1300	540	ND	300	1100	

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

Figure 1, Columbia Slough Tier II Sampling Event –May 18-19, 1999

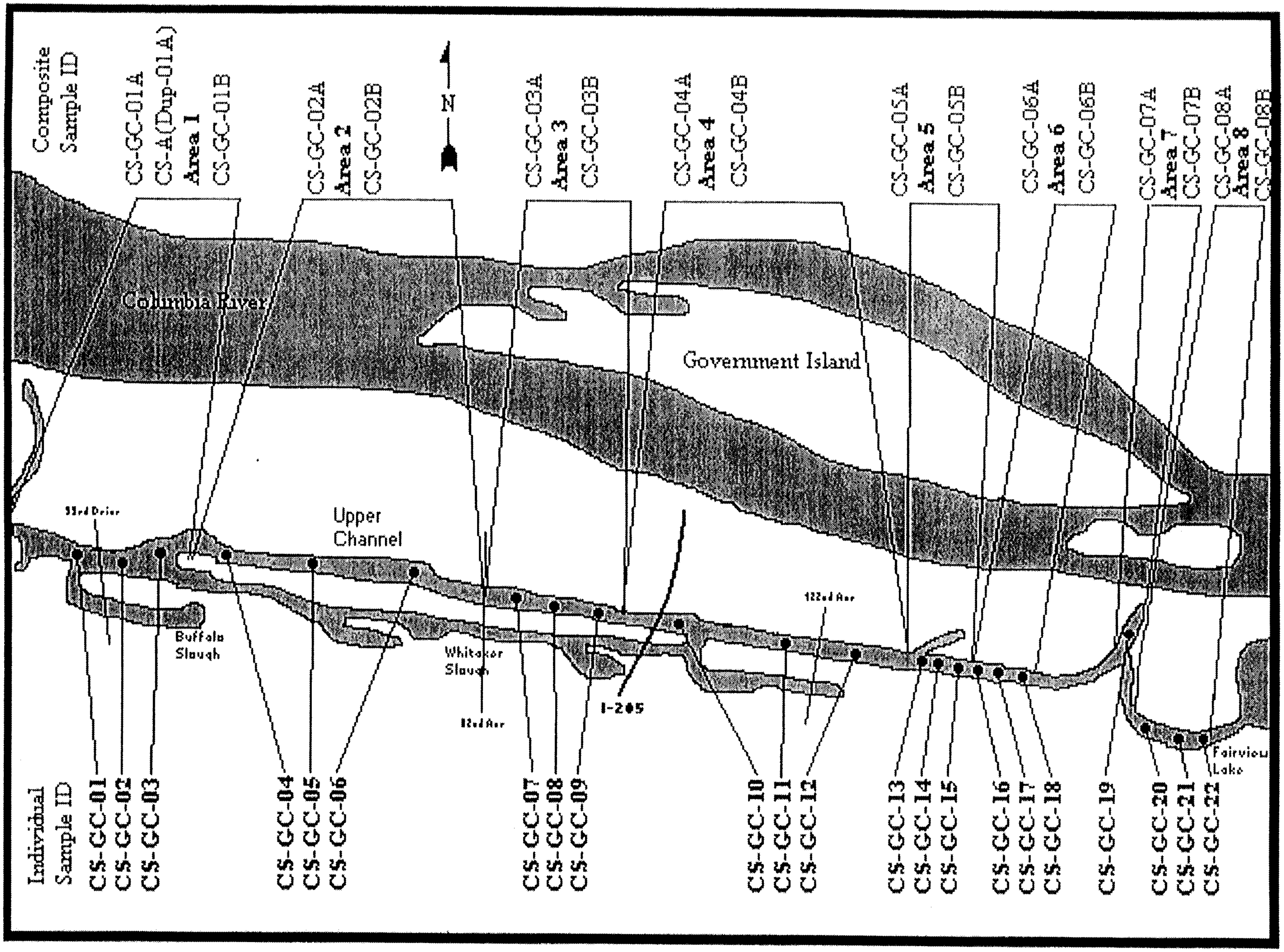
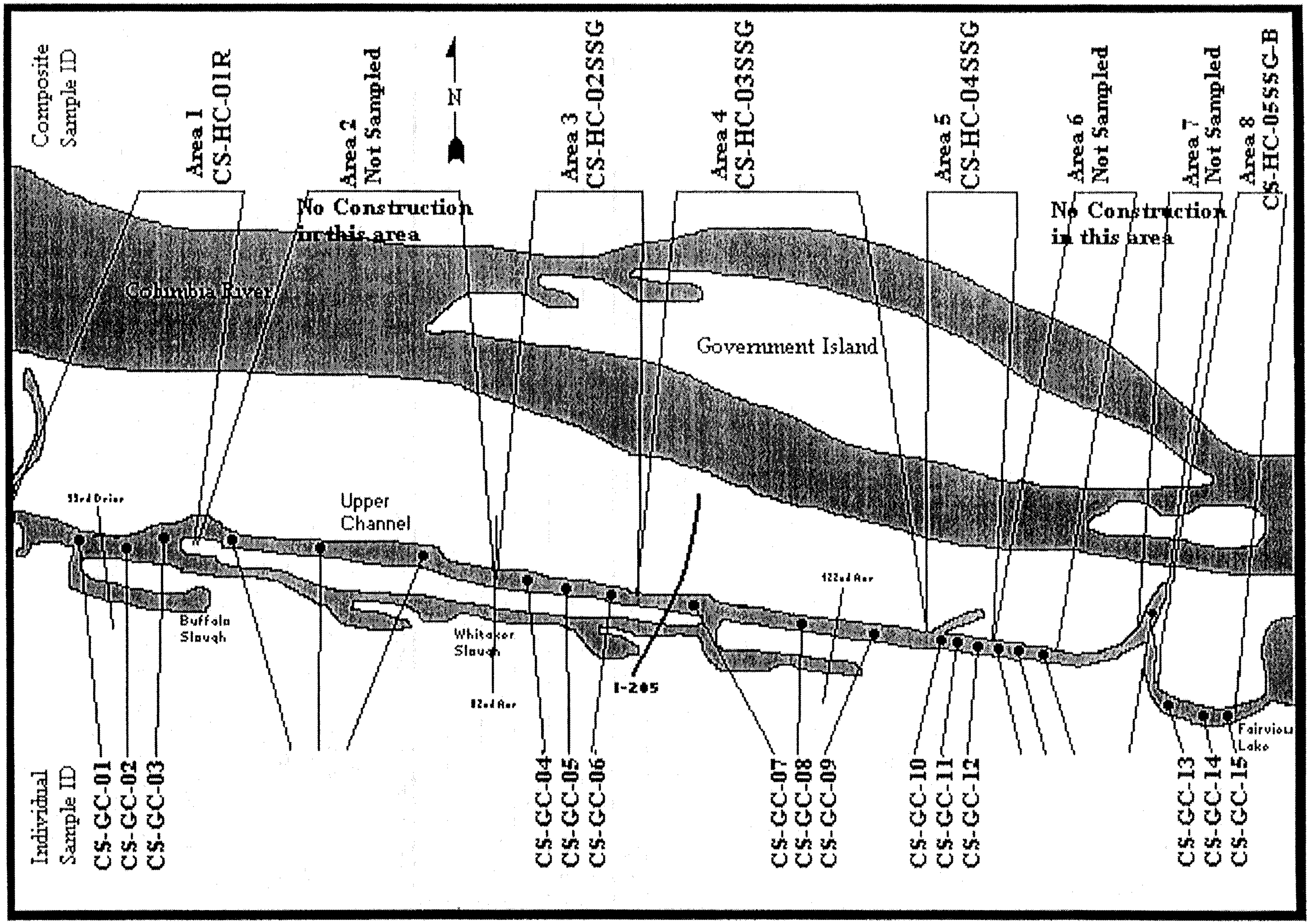


Figure 2, Columbia Slough Tier III Sampling Event –Oct 6, 1999



Attachment A
MEC Bioassay Evaluation

19 December 1999

USACE (Attn. Tim Sherman)
333 SW First Avenue
Portland, OR 97204

Dear Mr. Sherman:

This document is the final letter report for the dredged material disposal sediment toxicity testing (*Chironomus tentans*, *Hyalella azteca,* and *Limbriculus variegatus*) for Columbia Slough project sediments. Included in this letter report are copies of the Chain-of-Custody (COC) forms (Attach. 1), test organism receipt information (Attach. 2), laboratory bench sheets (Attach. 3), reference toxicant bench sheets (Attach. 4), sediment porewater ammonia and overlying ammonia data (Attach. 5), statistical analysis information (Attach. 6), temperature plots (Attach. 7), and TOC and grain size data (Attach. 8). Please see tables and text below for a summary of test results.

MEC laboratory personnel received five samples (CS-HC-02SSG, CS-HC-03SSG, CS-HC04SSG, CS-HC-05SSG-B, and CS-HC-01R (reference sediment)) for sediment toxicity tests reported herein. All samples were received 08 October 1999, and were evaluated in 10-day sediment toxicity tests with the freshwater amphipod, *H. azteca* and the midge, *C. tentans*. Samples CS-HC-01R and CS-HC-O5SSG-B were evaluated in a 28-day bioaccumulation test with the freshwater Oligocheate, *Lumbriculus variegatus.*

Table 1: Sample Identification and Collection Summary

Sample Description	Client Sample I.D.	MEC Sample I.D.	Date Collected	Date Received	COC #
Reference Sediment	CS-HC-01R	C991008.03	10/06/99	10/08/99	4009
Test Sediment	CS-HC-02SSG	C991008.04	10/06/99	10/08/99	4009
Test Sediment	CS-HC-03SSG	C991008.05	10/06/99	10/08/99	4009
Test Sediment	CS-HC-04SSG	C991008.06	10/06/99	10/08/99	4009
Test Sediment	CS-HC-05SSG-B	C991008.07	10/06/99	10/08/99	4009
Control Sediment	N.A. [1]	Control	N.A. [1]	N.A. [1]	N.A. [1]

[1] Not applicable (laboratory control sediment is clean sand obtained from a commercial supplier).

All samples were logged-in upon receipt. Upon receipt, the condition of each sample was noted and the temperature recorded on the COC form. All samples arrived in good conditions, however temperatures were slightly above the recommended shipping/storage temperature range of >0°C and <4°C (9.5 to 13.0°C). This deviation is not considered significant and is not expected to impact testing results. After being logged-in, samples were placed in a locked cold storage walk-in and held at 4°C until test initiation.

Sample handling, testing, and analysis was conducted in accordance with the Inland Testing Manual (ITM) (USEPA/USACE 1998) and the Dredged Material Evaluation Framework – Lower Columbia River Management Area (1998). Tests conducted by MEC included standard 10-day solid phase sediments toxicity tests with the freshwater amphipod, *Hyalella azteca* (USEPA 1994; as revised 1998, MEC SOP# BIO068.00) and the midge, *Chironomus tentans* (USEPA 1994; as revised 1998, MEC SOP# BIO069.00); and a 28-day bioaccumulation test with the freshwater oligochaete, *Lumbriculus variegatus*

Attachment A
MEC Bioassay Evaluation

(USEPA 1994, as revised 1998, MEC SOP# BIO057.00). Initial interstitial ammonia was measured on Day 0 for 10-day solid phase testing. Ammonia values ranged from 3.29 to 9.40mg/L in CS-HC-03SSG and CS-HC-05SSG-B, respectively. Prior to bioaccumulation testing, a small subsample was collected to evaluate porewater ammonia levels in the test sediments. Pre-test porewater ammonia levels ranged from 5.73 to 10.9mg/L total ammonia in the CS-HC-03SSG sediment and CS-HC-05SSG-B sediment, respectively (Table 4). Ten-day solid phase sediment toxicity tests with *H. azteca* and *C. tentans* were initiated on 09 November 1999; and the bioaccumulation test with *L. variegatus* was initiated on 29 October 1999. All tests with were initiated within the prescribed eight weeks, per ITM guidance. Test results are summarized in Table 2. Control survival in *H. azteca* (92.5%) met test acceptability criteria of 80% survival, whereas Reference (CS-HC-01R) survival (40%) did not meet the test acceptability criteria of 70%. There were no statistically significant effects in the *H. azteca* tests. Control survival (78.8%) and Reference (CS-HC-01R) survival (73.8%) in *C. tentans* met test acceptability criteria of 70% and 65%, respectively. Control ash free dry weight (1.48mg) in the test with *C. tentans* met the test acceptability criterion >0.6mg. Mean test mortality for *C. tentans* in the test sediment, CS-HC-02SSG, was statistically different and greater than 20% different (i.e. more than) from the mean reference response. In addition, the mean biomass for *C. tentans* in the test sediment, CS-HC-05SSG-B, was statistically significant and more than 40% different (i.e. less than) than the reference.

The test species, *H. azteca* and *C. tentans*, were also evaluated in reference toxicant tests with copper sulfate. Toxicant tests with *H. azteca* were exposed to nominal concentrations of 125, 250, 500, 1000, and 2000 Cu^{2+} µg/L. Toxicant tests with *C. tentans* were exposed to nominal concentrations of 250, 500, 1000, 2000, and 4000 Cu^{2+} µg/L. The LC_{50} for *H. azteca* (146.92µg/L) and *C. tentans* (388.9µg/L) were within two standard deviations of laboratory mean for each species (i.e., 477.8 ± 579.8µg/L for *H. azteca* and 834.0± 1413.6µg/L for *C. tentans*) indicating that test organisms were within the expected range of sensitivity to the reference toxicant.

Table 2: Summary of solid phase bioassay test results for Columbia Slough sediments.

	H. azteca			C. tentans		
Sample Name	% Survival (S.E.)			% Survival (S.E)	Mean Est. Indiv. Ash Free Dry wt. in mg (S.E)	
Control	92.5 (0.016)			78.8 (0.058)	1.48 (0.011)	
CS-HC-01R	40.0 (0.046)			73.8 (0.057)	0.89 (0.056)	
CS-HC-02SSG	80.0 (0.053)			28.8 (0.130)[1,3]	1.46 (0.285)	
CS-HC-03SSG	65.0 (0.057)			66.3 (0.092)	1.00 (0.081)	
CS-HC-04SSG	53.8 (0.053)			70.0 (0.073)	0.78 (0.084)	
CS-HC-05SSG-B	26.3 (0.046)			63.8 (0.073)	0.33 (0.055)[1,4]	
	Copper Conc. (µg/L)	% Survival	LC_{50}	Copper Conc. (µg/L)	% Survival	LC_{50}
Reference Toxicant	Control	100.0	146.9 µg/L	Control	90.0	388.9 µg/L
	125	60.0		250	56.7	
	250	20.0		500	46.7	
	500	3.3		1000	0.0	
	1000	0.0		2000	0.0	
	2000	0.0		4000	0.0	

[1] = t – test significantly different ($p \le 0.05$) relative to reference sediment.
[2] = survival > 15% reduced relative to reference (*H. azteca*).
[3] = survival > 20% reduced relative to reference (*C. tentans*).
[4] = reduction in biomass greater than 40% relative to reference.

Following the 28-day bioaccumulation test, *L. variegatus* were retrieved from the test sediment and measured. Test results are summarized in Table 3. Biomass of retrieved organisms ranged from 2.25 to 3.61grams in the Control and Reference (CS-HC-01R) sediments, respectively. Tissue samples were then frozen, and sent to Sound Analytical Systems for subsequent residue analysis.

Table 3: Summary of bioaccumulation test results for Columbia Slough sediments.

Sample Name	L. variegatus	
	Initial Weights grams	Mean Final Weights Grams (S.E.)
Control	5.00	2.91 (0.241)
CS-HC-01R	5.00	3.21 (0.170)
CS-HC-05SSG-B	5.00	2.80 (0.182)

Test conditions were within recommended limits for the *H. azteca* test species with the exception of temperature and pH. Temperature and pH were slightly outside the recommended ranges of 23±1°C (21.3 to 23.2°C); and 7.0 ± 1.0 (6.7 to 7.9), respectively. These excursions in temperature and pH were not significant (small and of short duration) and did not affect test results. Test conditions were within recommended limits for the *C. tentans* test species with the exception of temperature and dissolved oxygen. Temperature and dissolved oxygen were slightly outside the recommended ranges of 23±1°C (21.1 to 26.5°C); and >3.4mg/L (2.1 to 9.5mg/L), respectively. These excursions in temperature were not significant (small and of short duration) and did not affect test results. Aeration was begun on 17 November 1999 in order to rectify low dissolved oxygen concentrations. A summary of water quality during the 10-day solid phase tests with *H. azteca* and *C. tentans* is provided in Table 4. Test conditions were within recommended limits for the *L. variegatus* test species. Due to low initial dissolved oxygen readings, aeration was begun on 29 October 1999. A summary of water quality during the bioaccumulation test is provided in Table 5.

Attachment A
MEC Bioassay Evaluation

Table 4: Summary of Water Quality Data, Porewater Ammonia, and Overlying Ammonia for solid phase bioassay tests of Columbia Slough sediments.

H. azteca								
Sample Name	Water Quality Measurements				Porewater		Overlying	
	D.O mg/L (S.E.)	Temp. °C (S.E.)	Cond. MS/cm (S.E.)	pH Units (S.E.)	Initial mg/L	Final mg/L	Initial mg/L	Final mg/L
Control	7.5 (0.157)	21.6 (0.069)	0.30 (0.001)	7.6 (0.048)	0.063	0.0495	0.0049	0.239
CS-HC-01R	5.5 (0.132)	21.7 (0.065)	0.29 (0.001)	7.1 (0.018)	4.21	3.72	0.660	0.388
CS-HC-02SSG	5.6 (0.141)	21.7 (0.070)	0.29 (0.001)	7.0 (0.018)	5.20	4.12	0.837	0.666
CS-HC-03SSG	5.7 (0.169)	21.7 (0.065)	0.28 (0.001)	7.0 (0.021)	3.29	3.16	0.506	0.408
CS-HC-04SSG	5.5 (0.142)	21.7 (0.062)	0.28 (0.001)	7.0 (0.018)	6.70	4.97	0.964	0.951
CS-HC-05SSG-B	5.8 (0.123)	21.7 (0.063)	0.29 (0.001)	7.1 (0.014)	9.40	7.08	1.38	1.54
Reference Toxicant	8.4 (0.071)	22.4 (0.100)	0.30 (0.002)	7.7 (0.101)				

C. tentans								
Sample Name	Water Quality Measurements				Porewater		Overlying	
	D.O mg/L (S.E.)	Temp. °C (S.E.)	Cond. MS/cm (S.E.)	pH Units (S.E.)	Initial mg/L	Final mg/L	Initial mg/L	Final mg/L
Control	7.3 (0.413)	22.5 (0.228)	0.30 (0.001)	7.6 (0.061)	0.063	0.0495	0.0096	0.580
CS-HC-01R	6.4 (0.369)	22.5 (0.215)	0.29 (0.002)	7.2 (0.043)	4.21	3.72	0.750	0.214
CS-HC-02SSG	6.6 (0.358)	22.4 (0.219)	0.28 (0.002)	7.2 (0.049)	5.20	4.12	0.830	0.313
CS-HC-03SSG	6.8 (0.384)	22.5 (0.227)	0.28 (0.001)	7.2 (0.052)	3.29	3.16	0.566	0.712
CS-HC-04SSG	6.7 (0.438)	22.4 (0.219)	0.28 (0.001)	7.2 (0.065)	6.70	4.97	1.04	1.39
CS-HC-05SSG-B	6.4 (0.377)	22.5 (0.197)	0.29 (0.002)	7.2 (0.058)	9.40	7.08	1.74	2.05
Reference Toxicant	7.0 (0.294)	22.7 (0.079)	0.31 (0.004)	7.4 (0.044)				

Attachment A
MEC Bioassay Evaluation

Table 5: Summary of Water Quality Data, Pore Water Ammonia, and Overlying Ammonia for bioaccumulation tests of Lower Columbia River sediments.

L. variegatus							
Sample Name	Water Quality Measurements				Porewater Ammonia	Overlying Ammonia	
	D.O. % (S.E.)	Temp. °C (S.E.)	Cond. mS/cm (S.E.)	pH Units (S.E.)	Pretest mg/L	Initial mg/L	Final mg/L
Control	64.7 (2.590)	22.8 (0.096)	0.40 (0.003)	7.5 (0.037)	1.69	0.139	0.445
CS-HC-01R	79.7 (2.307)	23.1 (0.128)	0.28 (0.002)	7.2 (0.051)	5.73	1.44	0.0790
CS-HC-05SSG-B	78.5 (1.948)	23.2 (0.113)	0.28 (0.002)	7.2 (0.049)	10.9	2.58	0.0622

In summary, test results for solid phase tests with *C. tentans* indicated significant effects for survival in the test sediment CS-HC-02SSG, and significant effects on biomass in the test sediment CS-HC-05SSG-B. Results for solid phase tests with *H. azteca* could not be evaluated due to failure to meet test acceptability criteria for reference survival. Minimal biomass requirements for bioaccumulation tests with *L. variegatus* were met, and tissue residues were sent to Sound Analytical Systems for subsequent analysis. On the basis of these test results, it appears that the test sediments, CS-HC-02SSG and CS-HC-05SSG-B, are unsuitable for open water disposal in accordance with the one-hit failure rule described in the DMEF for the Lower Columbia River.

Thank you for the opportunity to conduct these tests on the Columbia Slough sediments. Should you have any questions regarding these test results or require additional information please contact me at 760-931-8081.

Sincerely,

David W. Moore, Ph.D.
Director of Toxicology and Chemistry
MEC Analytical Systems, Inc.

Attachment B
MEC Bioassay Evaluation

Bioaccumulation Test

The test sediment CS-HC-05SSG-B was evaluated in a twenty-eight day bioaccumulation test with the oligochaete, *Lumbriculus variegatus* to evaluate the potential for bioaccumulation of DDT and its metabolites. DDT tissue residues of organisms exposed to the test sediment were compared with tissue residues of animals exposed in parallel to the reference sediment CS-HC-01R. Test results are summarized in the table below.

Table X: Summary of bioaccumulation test results and analysis for the Columbia Slough sediment CS-HC-05SSG-B.

Sample I.D.	DDT Metabolite	Method Detection Limit (µg/kg)	Mean Tissue Conc. (µg/kg)	Steady State adjusted Tissue Concentration[1]	Comments
Control	4,4'-DDD	1.0	<0.70	N.A.	
	4,4'-DDE	1.0	<0.46	N.A.	
	4,4'DDT	1.0	<0.59	N.A.	
Reference CS-HC-01R	4,4'-DDD	1.0	<0.65	N.A.	
	4,4'-DDE	1.0	2.5	4.2	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	0.48	0.8	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (mortality in the Dragonfly) is 14.4 µg/Kg
CS-HC-05SSG-B	4,4'-DDD	1.0	<0.77	N.A.	
	4,4'-DDE	1.0	0.1 (0.55 in one of 5 replicates)	0.29	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	<0.64	N.A	

[1]Steady-state tissue concentrations were estimated based on a log K_{ow} value of 5.7 (from table 9-5 of the ITM) for DDT and DDE and using the function for the expected proportion of steady state concentration at 28-days developed by McFarland (1994) (figure 6-1 in the ITM).

Attachment B
MEC Bioassay Evaluation

Results of the tissue analysis indicate that measured DDT tissue residues were nearly all below the method detection limit (1.0µg/kg) in organisms exposed to the test sediment. All measured concentrations in both the test and reference organisms were well below the FDA action limit of 5,000 µg/kg (given as the sum of DDE & DDT).

While a trace amount of the metabolite 4,4′-DDE was measured at a level close to the sample detection limit in a single replicate of the test sediment exposed organisms, the measured tissue concentration of 4,4′-DDE (0.55µg/kg.) was less than the mean reference value of 2.5µg/kg and substantially less than the lowest relevant No Observable Effect Dose (NOED) (3,750 µg/kg) reported in the Environmental Residue-Effects Database (ERED).

Animals exposed to the reference sediment had measurable levels of 4,4′-DDE and 4,4′-DDT with mean values of 2.5µg/kg and 0.48 µg/kg, respectively. Both of these values were substantially less than the lowest relevant NOEDs reported in the ERED even after adjusting to an estimate of the steady-state concentration. The metabolite, 4,4′-DDD was not detected in either the reference or the test sediment exposed organisms.

Since DDT is known to biomagnify in aquatic food webs we used trophic transfer coefficients from the published literature to estimate potential risk to higher trophic organisms (i.e., fish consuming benthic infauna, piscivorous birds, and humans consuming fish). A biomagnification factor (BMF) of 30 was used to estimate the resultant tissue concentration in fish consuming *L. variegatus* with the measured DDT residues reported herein. This BMF estimate was based on work by Rasmussen et al. (1990) and Wang & Simpson (1996) which suggests a BMF of 30 to go from a planktonic prey item (i.e., artemia) to lake trout. Using this factor, the resultant tissue concentration in fish subsisting entirely on *L. variegatus* with a measured body burden of 5 µg/Kg ΣDDT (approximating the highest concentration reported herein) would be 150 µg/Kg (whole body), well below the lowest relevant effect dose for a freshwater fish reported in the ERED (e.g., a value of 1600 µg/Kg for 4.4'- DDE resulted in reduced growth in Lake Trout). This value also appears to be comparable to fish tissue residue values (10 – 470 µg/Kg p,p' DDE; <10 – 30 µg/Kg p,p' DDT) reported for a variety of sites in the Columbia River in 1991 (personal communication Chee Choy, City of Portland, Bureau of Env. Services). We also estimated the concentration in a piscivorous raptor's egg in order to evaluate the potential risk for eggshell thinning. To generate this estimate we used a BMF of 22 (calculated by Giesy et al. [1995] for Bald Eagles) to go from the estimated fish tissue concentration of 150 µg/Kg to a projected egg residue of 3,300 µg/Kg. This estimated egg residue value is less than the no observable effect concentration of 3,600 µg/Kg in eggs reported by Wiemeyer et al. for the Bald Eagle (1993). To evaluate the estimated whole body fish tissue concentration (for human health consumption concerns) the estimated concentration was adjusted to account for the conversion from a whole body concentration to a filet using a factor of 0.5 (i.e. assumes approximately half of the whole body concentration is in the filet, generally a factor of 0.3 is used). After adjustment the resulting tissue residues in the edible portion of the fish tissue was estimated to be 75 µg/Kg ΣDDT. This value is in line with residues reported as part of the FDA's latest published annual market survey (1998) for freshwater fish filets obtained from markets which resulted in values ranging between 0 and 51 µg/Kg ΣDDT (http://vm.cfsan.fda.gov/~download/ pes98db.html).

Attachment B
MEC Bioassay Evaluation

Based on this analysis, the measured tissue residues in the test sediment exposed organisms represents little to no risk to wildlife or humans. A similar evaluation of tissue residues in reference exposed organisms (which were higher than test sediment exposed organisms) showed that the measured tissue residues do not represent a significant risk to benthic infauna. Additionally, based on the conservative screening level assessment provided above, these measured DDT residues in reference exposed organisms appear to represent little to no risk to higher trophic organisms (predatory fish and Bald Eagles). Finally a comparison of estimated fish tissue residues (derived from reference site exposed organisms) results in human health risks comparable to that for fish obtained from the market.

References

Giesy et al. (1995). Arch. Environ. Contam. Toxicol. 29, 309-321.

Rasmussen et al. (1990). Can. J. Fish. Aquat. Sci. 47, 2030.

USEPA/ USACE 1998. Inland Testing Manual. EPA-823-B-98-004.

Wang and Simpson (1996). Bull. Environ. Contam. Toxicol. 56:888-895.

Wiemeyer et al. (1993). Arch. Environ. Contam. Toxicol. 24, 213-227.

**Attachment C - Multnomah County Drainage District
Presentation to the Dredge Material Management Team**

Columbia Slough Meandering Channel/Wetland Benches Project

Fact Sheet

Project Purpose

Creation of a meandering channel over various segments of a 10-mile stretch of the mainstem of the Middle and Upper Columbia Slough. The intended function of the channel deepening is to increase velocities to improve water quality during the low flow season and to provide wildlife and wetland habitat.

Project Description

The U.S Corps of Engineers is conducting a General Investigation (GI) Feasibility Study to evaluate a meandering channel in the Slough mainstem for water quality, wildlife and wetland enhancement benefits. Dredging would be conducted to an elevation of approximately 3 feet and the dredged material would be used to create wetland benches. These benches would be vegetated to support wildlife. Side casting would be used to create the meanders during low-water periods. The Multnomah County Drainage District (MCDD) which is responsible for maintaining the Slough channels would obtain the required 404/401 permits for conducting this project.

Project Background

Historical Chemistry Data Review

Historical data were reviewed to evaluate potential sediment issues related to inwater disposal (side casting) of Slough sediments. Numerous surface samples have been taken in the Slough mainstem on various dates and numerous locations. Most of the analyses were below the screening levels (SLs) of the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). Table 1 shows the exceedances of the SLs. Those analyses exceeding the SLs were 4 heavy metals, 3 phenol groups, 2 phthalate groups, 1 alcohol and 1 pesticide.

Sediment Sampling

After review of these data, the U.S Corps of Engineers conducted additional sampling to characterize the sediment of portions of the middle and upper Columbia Slough mainstem.

The US Army Corps of Engineers, Portland District personnel collected gravity core samples on May 18-19, 1999. The study area was divided into 8 sampling areas (see attached figure). The eight sampling composite areas were selected to give balanced coverage to the full-length study. Twenty-two individual cores were collected and composited with 3 samples per area (except area 7, one sample only). The eight composite core samples were divided, with the top representing the dredging prism and the bottom 6" to 12", representing the "newly exposed surface" after dredging is completed. Samples were analyzed for the following:

- Physical and Volatile Solids
- Metals and Total Organic Carbon (TOC)
- Pesticide/PCBs, Phenols, Phthalates and Misc. Extractables
- Polynuclear Aromatic Hydrocarbons (PAHs)

With few exceptions, the newly exposed surface has chemicals of concern at lower levels than the material in the dredging prism. The pesticide DDT was the only compound found in excess of the SL (6.9 ug/kg). Of 16 samples analyzed for DDT, 10 exceeded the SL with levels ranging from 7.1 to 51.3 ug/kg (Table 2). The bioaccumulation level of concern is 50 μg/kg; only one sample (CS-GC-08A in the dredging prism) exceeded this level at 51.3 μg/kg.

Biological Testing

Tier III biological testing was recommended to characterize potential biological effects from inwater disposal because of the DDT sediment concentrations greater than the SL and bioaccumulation level of concern. A list of dredging scenarios was developed from preliminary discussions of the meandering channel design to aid in determining what kind of bioassay sampling should be conducted. Table 3 provides information on proposed dredge locations and volumes, and the associated DDT concentrations in each area.

A review team, including DEQ, the Corps, the City of Portland, and MCDD recommended that five composite samples be collected, one each from Areas 1, 3, 4, 5, and 8. Each composite sample was comprised of three sediment samples collected from each area with a gravity core. The bioassays consisted of tests for 2 species (Amphipod – *Hyalella azteca* 10-day survival test and Midge – *Chironomus tentans* 10-day survival and growth test). The bioaccumulation test was conducted on one species (Oligocheate – *Limbriculus variegatus* 28-day tissue tesidue test). The testing is summarized below.

Area	Composite Bioassay Test	Composite Bioaccumulation Test	Composite DDT and Grain Size Analyses	# Samples/ composite
1[a]	1	1	1	3
2	--	--	--	None
3	1	--	1	3
4	1	--	1	3
5	1	--	1	3
6	--	--	--	None
7	--	--	--	None
8	1	1	1	3
[a] Reference site				

The results of the acute and chronic testing are summarized in Table 4. The amphipod results were inconclusive because the reference area failed to meet the acceptable survival criterion. The results of the midge bioassays indicated significant effects for survival in one sample (Area 3) and for growth in one sample (Area 8), but the results were somewhat inconclusive. Several things may have contributed to inconclusive results. Temperature and pH were slightly outside the recommended ranges. Ammonia levels, while not lethal, may have caused stress in some samples. It was noted that the reference and test sediments had significant amount of woody debris (small wood chips); wood chips contain resin alkaloids that are known to be acutely lethal to many benthic invertebrate species. None of these factors can be determined to be conclusive for the outcome of the bioassays.

The bioaccumulation testing for Area 8 was evaluated by comparing DDT tissue residues of organisms exposed to the test sediment with tissue residues of animals exposed in parallel to the reference sediment CS-HC-01R. Results of the tissue analysis indicate that measured DDT tissue residues were nearly all below the method detection limit (1.0 µg/kg) in organisms exposed to the test sediment (Table 5). All measured concentrations in both the test and reference organisms were well below the FDA action limit of 5,000 µg/kg (given as the sum of DDE & DDT).

Since DDT is known to biomagnify in aquatic food webs, trophic transfer coefficients from the published literature were used to estimate potential risk to higher trophic organisms (i.e., fish consuming benthic infauna, piscivorous birds, and humans consuming fish). A biomagnification factor (BMF) of 30 was used to estimate the resultant tissue concentration in fish consuming *L. variegatus* with the measured DDT residues. Based on this analysis, the measured tissue residues in the test sediment exposed organisms represents little to no risk to wildlife or humans. A similar evaluation of tissue residues in reference exposed organisms (which were higher than test sediment exposed organisms) showed that the measured tissue residues do not represent a significant risk to benthic infauna. Additionally, based on the conservative screening level assessment provided above, these measured DDT residues in reference exposed organisms appear to represent little to no risk to higher trophic organisms (predatory fish and Bald Eagles). Finally a comparison of estimated fish tissue residues (derived from reference site exposed organisms) results in human health risks comparable to that for fish obtained from the market.

Next Steps

The chemical testing conducted by the Corps in May 1999 indicated that the only contaminant exceeding the DMEF screening levels was DDT. Subsequent biological testing indicated no risk for bioaccumulation but the bioassay testing was somewhat inconclusive.

The project team proposes to the DMMT that this project be allowed to proceed based on 40 CFR 230.60 (c):

> "To reach the determinations in Sec. 230.11 involving potential effects of the discharge on the characteristics of the disposal site, the narrative guidance in subparts C through F shall be used along with the general evaluation procedure in Sec. 230.**60** and, if necessary, the chemical and biological testing sequence in Sec. 230.61. Where the discharge site is adjacent to the extraction site and subject to the same sources of

contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing will not be required." [Full text of 230.60 provided in Attachment A]

The 40 CFR 230.11 provides guidance of factual determinations for making findings of compliance or non-compliance with the restrictions on discharge [Full text of 230.11 provided in Attachment B]. The determinations of effects of each proposed discharge shall include the following:

(a) **Physical substrate determinations.** The purpose of this evaluation is determine if changes outside of the disposal site may occur as a result of erosion, slumpage, or other movement of the discharged material.

The project incorporates stabilization of the side-casted material with vegetation to prevent erosion or other movement of the dredged material.

(b) **Water circulation, fluctuation, and salinity determinations**. Requires determination of the nature and degree of effect that the proposed discharge will have individually and cumulatively on water, current patterns, circulation including downstream flows, and normal water fluctuation.

The project is designed to improve water circulation and quality.

(c) **Suspended particulate/turbidity determinations**. Requires determination of the nature and degree of effect that the proposed discharge will have, individually and cumulatively, in terms of potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site.

Measures will be taken to minimize suspension of particulates, including stopping flow in the Slough during the activity and stabilization of the dredged benches after placement. Because MCDD can control flows and water levels within the project area, effective controls during construction of the project can be implemented. Long-term benefits of the project include increased solids retention by vegetation on the benches.

(d) **Contaminant determinations**. Requires determination of the degree to which the material proposed for discharge would introduce, relocate, or increase contaminants.

Proposed project will not increase contaminant, since material is being placed within the general area that it is dredged. Even if all material was disposed upland, the long-term redeposition of the same contaminants from the watershed is anticipated in the Slough.

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(e) Aquatic ecosystem and organism determinations. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms.

Project designed to enhance structure and function of aquatic and wetland ecosystems.

Table 1. Historical Columbia Slough Sediment Project Data[1]

Sampling Area	Sample ID	Parameter	VALUE	Q	LCRMA Screening Levels[2]	Value Exceeds LCRMA	UNITS	DL	PQL
1	CSUTS002100	4-Methylphenol	3300	E	670	x	ug/kg-dry	28	87
	CSUTS002100-DL	4-Methylphenol	3100		670	x	ug/kg-dry	55	170
	CSURS014300	Total DDT	12.3		6.9	X	ug/kg-dry	NA	NA
	CSURS025400	Total DDT	8.5		6.9	X	ug/kg-dry	NA	NA
	CSURS068500	Total DDT	12.2		6.9	X	ug/kg-dry	NA	NA
	CSURS068500-DL	Total DDT	9		6.9	X	ug/kg-dry	NA	NA
	CSURS110200	Total DDT	15.6		6.9	X	ug/kg-dry	NA	NA
	CSURS123500	Total DDT	13.1		6.9	X	ug/kg-dry	NA	NA
	CSUTS001500	Total DDT	13.8		6.9	X	ug/kg-dry	NA	NA
2	CSURS235500	Benzyl Alcohol	65	JM	57	x	ug/kg-dry	22	140
	CSURS175200	Total DDT	24.3		6.9	X	ug/kg-dry	NA	NA
	CSURS175200-DL	Total DDT	17.2		6.9	X	ug/kg-dry	NA	NA
	CSURS195400	Total DDT	9.4		6.9	X	ug/kg-dry	NA	NA
	CSURS212100	Total DDT	23		6.9	X	ug/kg-dry	NA	NA
	CSURS235500	Total DDT	44.1		6.9	X	ug/kg-dry	NA	NA
	CSURS265200	Total DDT	9.1		6.9	X	ug/kg-dry	NA	NA
	CSURS294500	Total DDT	17.7		6.9	X	ug/kg-dry	NA	NA
	CSURS308100	Total DDT	25.8		6.9	X	ug/kg-dry	NA	NA
	CSURS329400	Total DDT	7.4		6.9	X	ug/kg-dry	NA	NA
	CSUTS302500	Total DDT	9.8		6.9	X	ug/kg-dry	NA	NA
3	CSURS436400	4-Methylphenol	1400		670	x	ug/kg-dry	47	150
	CSURS416100	Total DDT	18.4		6.9	X	ug/kg-dry	NA	NA
	CSURS436400	Total DDT	9.2		6.9	X	ug/kg-dry	NA	NA
4	CSURS485200	2,4-Dimethylphenol	1000		29	x	ug/kg-dry	150	460
	CSURS485200	2-Methylphenol	460		63	x	ug/kg-dry	85	270
	CSURS485200	Benzyl Alcohol	1300		57	x	ug/kg-dry	44	290
	CSURS496400	4-Methylphenol	1200		670	x	ug/kg-dry	22	70
	CSURS496400	Total DDT	15.5		6.9	X	ug/kg-dry	NA	NA
	CSURS533300	Total DDT	15		6.9	X	ug/kg-dry	NA	NA
	CSURS573200	Total DDT	17.5		6.9	X	ug/kg-dry	NA	NA
	CSURS585500	Total DDT	9.2		6.9	X	ug/kg-dry	NA	NA
	CSURS604500	Total DDT	8		6.9	X	ug/kg-dry	NA	NA
	CSURS623200	Total DDT	27.9		6.9	X	ug/kg-dry	NA	NA
	CSUTS501300	Total DDT	17.9		6.9	X	ug/kg-dry	NA	NA

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Table 1. Historical Columbia Slough Sediment Project Data[1]

Sampling Area	Sample ID	Parameter	VALUE	Q	LCRMA Screening Levels[2]	Value Exceeds LCRMA	UNITS	DL	PQL
	CSUTS602300	Total DDT	23.1		6.9	X	ug/kg-dry	NA	NA
	CSUTS502100	4-Methylphenol	880		670	x	ug/kg-dry	16	52
	CSURS604500	4-Methylphenol	800		670	x	ug/kg-dry	27	85
5	CSSTS002500	Lead	510		450	x	mg/kg-dry		
	CSSTS002500	Zinc	722		410	x	mg/kg-dry		
6	CSSTS101500	Bis(2-Ethylhexyl)Phthalate	11000	E	8300	x	ug/kg-dry	10	32
	CSSTS101500-DL	Bis(2-Ethylhexyl)Phthalate	38000		8300	x	ug/kg-dry	310	960
	CSSRS119300	Mercury	0.51		0.41	x	mg/kg-dry		
	CSSRS058100	Total DDT	13.7		6.9	X	ug/kg-dry	NA	NA
	CSSRS093200	Total DDT	36.2		6.9	X	ug/kg-dry	NA	NA
	CSSTS102500	Bis(2-Ethylhexyl)Phthalate	40000	E	8300	x	ug/kg-dry	170	550
	CSSTS102500-DL	Bis(2-Ethylhexyl)Phthalate	31000		8300	x	ug/kg-dry	350	1100
	CSSTS102500	Butylbenzyl Phthalate	1100	M	970	x	ug/kg-dry	96	300
	CSSTS102500	Cadmium	36		5.1	x	mg/kg-dry		
	CSSTS102500	Lead	510		450	x	mg/kg-dry		
	CSSTS102500	Zinc	1320		410	x	mg/kg-dry		
	CSSTS102501	Bis(2-Ethylhexyl)Phthalate	59000	E	8300	x	ug/kg-dry	130	400
	CSSTS102501-DL	Bis(2-Ethylhexyl)Phthalate	32000		8300	x	ug/kg-dry	1300	4000
	CSSTS102501	Cadmium	84		5.1	x	mg/kg-dry		
	CSSTS102501	Lead	520		450	x	mg/kg-dry		
	CSSTS102501	Zinc	1310		410	x	mg/kg-dry		
8	EDSTS201600	Dieldrin	0.02		0.01	x	mg/kg-dry		0.01
	CSSRS220400	4-Methylphenol	790		670	x	ug/kg-dry	26	83
	EDSTS202600	Dieldrin	0.02		0.01	x	mg/kg-dry		0.01
	CSSRS205300	Total DDT	9.9		6.9	X	ug/kg-dry	NA	NA
	CSSRS220400	Total DDT	16.6		6.9	X	ug/kg-dry	NA	NA
	CSSTS202500	Bis(2-Ethylhexyl)Phthalate	3800	E	8300		ug/kg-dry	17	54
	CSSTS202500-DL	Bis(2-Ethylhexyl)Phthalate	16000		8300	x	ug/kg-dry	140	430

[1] Data from the City of Portland: Columbia Slough Sediment Project, Screening Level Risk Assessment Report, Feb.1995. Only exceedances are shown.

[2]Source: USACE. 1998. Dredged Material Evaluation Framework, Lower Columbia River Management Area Draft.

Screening level = Concentrations at or below which there is no reason to believe that dredged material disposal would result in unacceptable adverse effects due to toxicity measured by sediment bioassays (suitable for aquatic disposal without the need for biological testing). These screening values were developed for the marine environment; freshwater values are under development.

Notes:

No qualifier definitions were given with database.

Table 2. Columbia Slough GI Study Pesticides (ug/kg) Results, Sampled May 18-19, 1999

Sample I.D.	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total DDT	Aldrin	Dieldrin	Alpha-BHC	Delta-BHC	Endosulfan 1	Endrin	Endrin aldehyde	Hepta chlor	Hepta chlor epoxide
CS-GC-01A	<0.58	*2.1*	<2.0	2.1	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-A (DUP--01A)	*1.8*	*3.5*	<2.0	5.2	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-01B	<0.33	<0.69	<2.4	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02A	*2.8*	*2.5*	<1.8	5.3	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-02B	<0.26	<0.54	<1.9	ND	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03A	*4.3*	*6.5*	<2.2	**10.8**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-03B	*1.9*	*2.8*	<1.8	**4.7**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-04A	*5.5*	*8.9*	<2.1	**14.4**	<0.12	<0.11	<0.12	<0.12	*1.2*	<0.19	*12*	<0.16	<0.26
CS-GC-04B	*1.7*	*1.3*	<1.7	**3.0**	<0.12	<0.11	<0.12	*0.37*	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-05A	*14*	*17*	<2.4	**31.0**	*1.6*	*0.94*	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	*0.46*
CS-GC-05B	*3.9*	*7.4*	<2.1	**11.3**	<0.12	<0.11	<0.12	<0.12	<0.51	<0.19	<1.4	<0.16	<0.26
CS-GC-06A	*6.3*	*8.6*	<2.4	**14.9**	<0.12	<0.11	*0.39*	<0.12	*0.72*	<0.19	<1.4	<0.16	<0.26
CS-GC-06B	*2.8*	*4.3*	<1.7	**7.1**	<0.12	<0.11	<0.12	*0.24*	<0.51	<0.19	<1.4	*0.17*	<0.26
CS-GC-07A	*14*	*29*	<3.2	**43.0**	<0.12	<0.11	*0.71*	<0.12	<0.51	<0.19	*5.1*	<0.16	*0.58*
CS-GC-07B	*16*	*22*	*3.9*	**41.9**	<0.12	<0.11	<0.12	<0.12	*1.1*	<0.19	<1.4	<0.16	<0.26
CS-GC-08A	*21*	*25*	*5.3*	**51.3**	<0.12	*1.2*	*0.47*	<0.12	<0.51	*1.2*	<1.4	<0.16	*1.8*
CS-GC-08B	*12*	*16*	*5.5*	**33.5**	<0.12	*1.0*	*0.55*	<0.12	<0.51	*0.78*	*2.9*	<0.16	*1.7*
Screen level (SL)	DDD + DDE + DDT =			**6.9**	10	10	*	*	*	*	*	*	*
Mean	6.4	9.2	0.9	**16.5**	0.94	0.18	0.04	0.04	0.14	0.07	1.18	0.01	0.26
Maximum	21	25	5.5	**51.3**	1.6	1.2	0.71	0.37	1.2	1.2	12	0.17	1.8

Values detected for DDT were confirmed with second column.

* SL has not been established.

Symbol (<) = Non-detect (ND) at the value listed (Method Detection Limit)

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Table 3. Preliminary Meandering Channel Design Summary

Area	Location	Proposed Dredging	Dredge Volume (cubic yards)	Inwater Disposal?	Dredging Prism DDT (ug/kg)	Bottom of Core DDT (ug/kg)
1	MCDD #1 to Whitaker Slough	Dredge to elevation 0ft	N/A	Yes	2.1	ND
2	Whitaker Slough to 78th Avenue	Dredge to elevation 0ft	N/A	Yes	5.3	ND
	78th to 82nd Avenue	Dredge to elevation 2ft	N/A	Yes	5.3	ND
3	82nd Avenue to 92nd Avenue	Dredge to elevation 2ft	13,000	Yes	10.8	4.7
4	92nd Avenue to I-205					
	I-205 to 122nd Avenue	Dredge to elevation 2ft	38,000	Yes	14.4	3.0
	122nd Avenue to 138th Avenue					
5	138th Avenue to Mid-dike levee	Dredge to elevation 2ft				
	Mid-dike levee to 148th Avenue	Dredge to elevation 3ft	28,300	Yes	31	11.3
	148th Avenue to 158th Avenue	Dredge to elevation 2ft				
6	158th Avenue to Four Corners	None	N/A	No	14.9	7.1
7	Four Corners to MCDD #4	None	N/A	No	43	41.9
8	Four Corners to Bridge B	None	N/A	No	51.3	33.5
	Bridge B to Bridge C	Dredge to elevation 5ft		Yes	51.3	33.5
	Bridge C through vegetated area east of 185th Avenue bridge	None	13,000	No	51.3	33.5
	East of 185th Avenue to Fairview Lake	Dredge to elevation 5ft		Yes	51.3	33.5

ND = Not detected
N/A = Non-Applicable

Table 4. Summary of Acute and Chronic Bioassays									
Area	Sample	H. azteca	C. tentans				Initial Porewater NH3		Organic
		% Survival	% Survival	Growth (mg)	% fines	% TOC	(mg N/L)	ΣDDT (ug/kg)	Carbon (ug/g)
	Control	92.5 (0.016)	78.8 (0.058)	1.48 (0.011)	2	0.02	0.06	N.A.	N.A.
1	CS-HC-01R	40.0 (0.046)	73.8 (0.057)	0.89 (0.056)	44	1.2	4.2	6.1	0.5
3	CS-HC-02SSG	80.0 (0.053)	28.8 (0.130)	1.46 (0.285)	50	1.6	5.2	2.4	0.15
4	CS-HC-03SSG	65.0 (0.057)	66.3 (0.092)	1.00 (0.081)	65	1.6	3.3	2.7	0.17
5	CS-HC-04SSG	53.8 (0.053)	70.0 (0.073)	0.78 (0.084)	91	2.3	6.7	5.5	0.235
8	CS-HC-05SSG-B	26.3 (0.046)	63.8 (0.073)	0.33 (0.055)	65	2.7	9.4	9.8	0.365

Table 5: Summary of bioaccumulation test results and analysis for the Columbia Slough sediment CS-HC-05SSG-B.

Sample I.D.	DDT Metabolite	Method Detection Limit (µg/kg)	Mean Tissue Conc. (µg/kg)	Steady State adjusted Tissue Concentration[1]	Comments
Control	4,4'-DDD	1.0	<0.70	N.A.	
	4,4'-DDE	1.0	<0.46	N.A.	
	4,4'DDT	1.0	<0.59	N.A.	
Reference CS-HC-01R	4,4'-DDD	1.0	<0.65	N.A.	
	4,4'-DDE	1.0	2.5	4.2	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	0.48	0.8	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (mortality in the Dragonfly) is 14.4 µg/Kg
CS-HC-05SSG-B	4,4'-DDD	1.0	<0.77	N.A.	
	4,4'-DDE	1.0	0.1 (0.55 in one of 5 replicates)	0.29	Lowest No Observable Effect Dose (NOED) reported in the ERED for a freshwater invertebrate (time of development in the midge, *C. tentans*) is 3,750 µg/Kg.
	4,4'DDT	1.0	<0.64	N.A	

[1]Steady-state tissue concentrations were estimated based on a log K_{ow} value of 5.7 (from table 9-5 of the ITM) for DDT and DDE and using the function for the expected proportion of steady state concentration at 28-days developed by McFarland (1994) (figure 6-1 in the ITM).

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[Code of Federal Regulations]
[Title 40, Volume 17, Parts 190 to 259]
[Revised as of July 1, 1999]
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[Page 260-261]
TITLE 40--PROTECTION OF ENVIRONMENT AGENCY (CONTINUED)

PART 230--SECTION 404(b)(1) GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL--Table of Contents

Subpart G--Evaluation and Testing Sec.
230.**60** General evaluation of dredged or fill material.

The purpose of these evaluation procedures and the chemical and biological testing sequence outlined in Sec. 230.61 is to provide information to reach the determinations required by Sec. 230.11. Where the results of prior evaluations, chemical and biological tests, scientific research, and experience can provide information helpful in making a determination, these should be used. Such prior results may make new testing unnecessary. The information used shall be documented. Where the same information applies to more than one determination, it may be documented once and referenced in later determinations.

(a) If the evaluation under paragraph (b) indicates the dredged or fill material is not a carrier of contaminants, then the required determinations pertaining to the presence and effects of contaminants can be made without testing. Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material. Dredged material so composed is generally found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels. However, when such material is discolored or contains other indications that contaminants may be present, further inquiry should be made.

(b) The extraction site shall be examined in order to assess whether it is sufficiently removed from sources of pollution to provide reasonable assurance that the proposed discharge material is not a carrier of contaminants. Factors to be considered include but are not limited to:

(1) Potential routes of contaminants or contaminated sediments to the extraction site, based on hydrographic or other maps, aerial photography, or other materials that show watercourses, surface relief, proximity to tidal movement, private and public roads, location of buildings, municipal and industrial areas, and agricultural or forest lands.

(2) Pertinent results from tests previously carried out on the material at the extraction site, or carried out on similar material for other permitted projects in the vicinity. Materials shall be considered similar if the sources of contamination, the physical configuration of the sites and the sediment composition of the materials are comparable, in light of water circulation and stratification, sediment accumulation and general sediment characteristics. Tests from other sites may be relied on only if no changes have occurred at the extraction sites to render the results irrelevant.

(3) Any potential for significant introduction of persistent pesticides from land runoff or percolation;

(4) Any records of spills or disposal of petroleum products or substances designated as hazardous under section 311 of the Clean Water Act (See 40 CFR part 116);

(5) Information in Federal, State and local records indicating significant introduction of pollutants from industries, municipalities, or other sources, including types and amounts of waste materials discharged along the potential routes of contaminants to the extraction site; and

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(6) Any possibility of the presence of substantial natural deposits of minerals or other substances which could be released to the aquatic environment in harmful quantities by man-induced discharge activities.

(c) To reach the determinations in Sec. 230.11 involving potential effects of the discharge on the characteristics of the disposal site, the narrative guidance in subparts C through F shall be used along with the general evaluation procedure in Sec. 230.**60** and, if necessary, the chemical and biological testing sequence in Sec. 230.61. Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing will not be required.

(d) Even if the Sec. 230.**60**(b) evaluation (previous tests, the presence of polluting industries and information about their discharge or runoff into waters of the U.S., bioinventories, etc.) leads to the conclusion that there is a high probability that the material proposed for discharge is a carrier of contaminants, testing may not be necessary if constraints are available to reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site, if such constraints are acceptable to the permitting authority and the Regional Administrator, and if the potential discharger is willing and able to implement such constraints. However, even if tests are not performed, the permitting authority must still determine the probable impact of the operation on the receiving aquatic ecosystem. Any decision not to test must be explained in the determinations made under Sec. 230.11.

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TITLE 40--PROTECTION OF ENVIRONMENT AGENCY (CONTINUED)

PART 230--SECTION 404(b)(1) GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL--Table of Contents

Subpart B--Compliance With the Guidelines

Sec. 230.**11** Factual determinations.

The permitting authority shall determine in writing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment in light of subparts C through F. Such factual determinations shall be used in Sec. 230.12 in making findings of compliance or non-compliance with the restrictions on discharge in Sec. 230.10. The evaluation and testing procedures described in Sec. 230.60 and Sec. 230.61 of subpart G shall be used as necessary to make, and shall be described in, such determination. The determinations of effects of each proposed discharge shall include the following:

(a) Physical substrate determinations. Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, on the characteristics of the substrate at the proposed disposal site. Consideration shall be given to the similarity in particle size, shape, and degree of compaction of the material proposed for discharge and the material constituting the substrate at the disposal site, and any potential changes in substrate elevation and bottom contours, including changes outside of the disposal site which may occur as a result of erosion, slumpage, or other movement of the discharged material. The duration and physical extent of substrate changes shall also be considered. The possible loss of environmental values (Sec. 230.20) and actions to minimize impact (subpart H) shall also be considered in making these determinations. Potential changes in substrate elevation and bottom contours shall be predicted on the basis of the proposed method, volume, location, and rate of discharge, as well as on the individual and combined effects of current patterns, water circulation, wind and wave action, and other physical factors that may affect the movement of the discharged material.

(b) Water circulation, fluctuation, and salinity determinations. Determine the nature and degree of effect that the proposed discharge will have individually and cumulatively on water, current patterns, circulation including downstream flows, and normal water fluctuation. Consideration shall be given to water chemistry, salinity, clarity, color, odor, taste, dissolved gas levels, temperature, nutrients, and eutrophication plus other appropriate characteristics. Consideration shall also be given to the potential diversion or obstruction of flow, alterations of bottom contours, or other significant changes in the hydrologic regime. Additional consideration of the possible loss of environmental values (Secs. 230.23 through 230.25) and actions to minimize impacts (subpart H), shall be used in

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making these determinations. Potential significant effects on the current patterns, water circulation, normal water fluctuation and salinity shall be evaluated on the basis of the proposed method, volume, location, and rate of discharge.

(c) Suspended particulate/turbidity determinations. Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, in terms of potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site. Consideration shall be given to the grain size of the material proposed for discharge, the shape and size of the plume of suspended particulates, the duration of the discharge and resulting plume and whether or not the potential changes will cause violations of applicable water quality standards. Consideration should also be given to the possible loss of environmental values (Sec. 230.21) and to actions for minimizing impacts (subpart H). Consideration shall include the proposed method, volume, location, and rate of discharge, as well as the individual and combined effects of current patterns, water circulation and fluctuations, wind and wave action, and other physical factors on the movement of suspended particulates.

(d) Contaminant determinations. Determine the degree to which the material proposed for discharge will introduce, relocate, or increase contaminants. This determination shall consider the material to be discharged, the aquatic environment at the proposed disposal site, and the availability of contaminants.

(e) Aquatic ecosystem and organism determinations. Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms. Consideration shall be given to the effect at the proposed disposal site of potential changes in substrate characteristics and elevation, water or substrate chemistry, nutrients, currents, circulation, fluctuation, and salinity, on the recolonization and existence of indigenous aquatic organisms or communities. Possible loss of environmental values (Sec. 230.31), and actions to minimize impacts (subpart H) shall be examined. Tests as described in Sec. 230.61 (Evaluation and Testing), may be required to provide information on the effect of the discharge material on communities or populations of organisms expected to be exposed to it.

(f) Proposed disposal site determinations. (1) Each disposal site shall be specified through the application of these Guidelines. The mixing zone shall be confined to the smallest practicable zone within each specified disposal site that is consistent with the type of dispersion determined to be appropriate by the application of these Guidelines. In a few special cases under unique environmental conditions, where there is adequate justification to show that widespread dispersion by natural means will result in no significantly adverse environmental effects, the discharged material may be intended to be spread naturally in a very thin layer over a large area of the substrate rather than be contained within the disposal site.

(2) The permitting authority and the Regional Administrator shall consider the following factors in determining the acceptability of a proposed mixing zone:

(i) Depth of water at the disposal site;

(ii) Current velocity, direction, and variability at the disposal site;

(iii) Degree of turbulence;

(iv) Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site;

(v) Discharge vessel speed and direction, if appropriate;

(vi) Rate of discharge;
(vii) Ambient concentration of constituents of interest;
(viii) Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities;
(ix) Number of discharge actions per unit of time;
(x) Other factors of the disposal site that affect the rates and patterns of mixing.
(g) Determination of cumulative effects on the aquatic ecosystem.
(1) Cumulative impacts are the changes in an aquatic

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ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.

(2) Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit applications, the issuance of a General permit, and monitoring and enforcement of existing permits.

(h) Determination of secondary effects on the aquatic ecosystem.

(1) Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final section 404 action is taken by permitting authorities.

(2) Some examples of secondary effects on an aquatic ecosystem are fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the U.S. Activities to be conducted on fast land created by the discharge of dredged or fill material in waters of the United States may have secondary impacts within those waters which should be considered in evaluating the impact of creating those fast lands.

APPENDIX B

Columbia Slough

Vegetation Plantings

2/2/99

3.3 RIPARIAN VEGETATION

3.3.1 DESCRIPTION

The Watershed Revegetation Program was developed to restore and maintain native vegetation in the upland, riparian, and wetland habitats of watersheds located in the City of Portland. The program accomplishes this task by focusing on several issues: the removal of exotic, invasive plants that are out-competing native plant communities; reducing erosion into streams and sloughs by using bioengineering techniques; and enhancing, restoring and creating wetland habitat to help replace wetland losses due to development and lack of vegetation management.

A. Riparian Revegetation (restoration)

Riparian corridors within the environmental overlay zones extend over the entire length of the Columbia Slough and range from 25 to 50 feet in width depending upon location in the slough. These areas are currently degraded and inoculated with exotic plant species such as Himalayan blackberry and reed canary grass. Partnerships between BES and both public and private landowners enable revegetation projects to be implemented within these E-zones.

Riparian Site Preparation
Site preparation allows access to planting sites and provides open initial growing conditions for planted seedlings. Workers cut exotic vegetation using chainsaws, weedeaters, or industrial mowing equipment, depending on site conditions such as bank configuration and access. Native vegetation is left uncut.

Immediately prior to planting, planters scalp (scrape away grass sod and other vegetation with a planting tool) a two-foot diameter planting spots to reduce vegetative competition and improve planting quality.

B. Wetland Benches (creation)

Areas along levees in the Penninsul-1 and Penninsula-2 drainage districts have been identified for wetland benching projects. The Watershed Revegetation Program works in partnership with the Multnomah County Drainage District and landowners to provide and implement cost-effective solutions to problems arising from degraded waterways. Wetland benching along the toes of these levees is designed to stabilize the levees and to grow native trees, shrubs, and wetland plants. Benches are classified as 'overbuilds', meaning they are not part of the levee proper and may be planted without threatening the integrity of the levee.

C. Natural Wetland (creation, restoration, and enhancement)

Hydrology is a key factor in determining species composition and richness, primary productivity, organic accumulation and nutrient cycling. The program examines surface and ground water levels, hydroperiods, seasonal pulses, flow patterns, retention times and soil characteristics. Excavation and grading plans are then designed to utilize the natural conditions of the landscape to restore the wetland. Program components include site excavation and grading, vegetation management, and wetland and upland planting.

Natural Wetland and Benching Excavation & Site Preparation

Selected sites are excavated to restore natural wetland hydrology. All excavation and construction are initiated and completed in the dry season (August and September) to minimize erosion concerns. After contouring is completed all soil is subsoiled to a depth of 5 feet to free site of compacted soil. All non-native vegetation is removed during excavation. Creating natural wetland hydrology through contouring and treating soil to remove compaction are key goals of the program because they are fundamental for long term success of any wetland site.

D. General Program Description

Erosion Control

Erosion prevention at newly excavated sites maintains local water quality. Since wetland excavation requires earthwork, erosion prevention techniques are applied immediately after excavation and grading. Erosion is controlled by beginning excavation in late summer or early fall, seeding the area with native grasses (as described in the section on Revegetation Strategy), covering exposed ground with a layer of winter wheat straw at the rate of 2 tons per acre, and installing jute netting with live pole cuttings on steep slopes. Projects where the program has applied these highly effective techniques are available for viewing at 122nd Avenue on Whitaker Slough and at NE Sunderland Avenue.

Plant Material

All plant material installed on restoration project sites is native to the Portland area. The plant inventory is stocked from several nurseries that grow local, native species and Portland Parks Mount Tabor Nursery, which works in conjunction with BES. Seed from native trees and shrubs are collected throughout the year, processed, and propagated at Mount Tabor Nursery and local private nurseries. Collecting and propagating local, native seed preserves local plant genetics, increases survival and growth rates, aims to restore native plant communities, and is cost effective.

Revegetation Strategy

The revegetation strategy effectively uses native plants, live pole cuttings and seeds to establish functional plant communities. Attachment B shows a general planting plan with scaled plant spacing. Enhancement projects are site specific, but the figure represents a "typical" planting layout. The figure illustrates the three basic planting zones at an enhancement project (emergent wetland, scrub/shrub wetland, and riparian upland). All three zones are seeded with grass/emergent seed mixes at the rate of 12-15 lbs. per acre. Wetland plugs are planted on 30 % to 50% of the wetland emergent zone with a density of 2 plants per square feet. Scrub/shrub wetland zones will have approximately 70% of the zone planted with bare-root shrubs and trees at 4-6 foot spacing and 10% of the zone will be planted with live pole cuttings at two foot spacing. Upland areas will be planted with bare-root trees at a 7-foot spacing. Upland shrubs will be interplanted on approximately 30% of the area (See Table 1 for actual number of plants per acre for each zone). Attachment A lists the native plant species, arranged by habitat, that are used for revegetation.

TABLE 1 - PLANTING AND SEEDING RATES PER ACRE

Zone	Plants/Acre	Seeding Rate/acre
Emergent Wetlands		12lbs
Wetland Emergent Plugs	40,000-90,000	
Scrub/Shrub Wetlands		15lbs
Trees/Shrubs	1490	
Pole Cuttings	1000	
Upland		15lbs
Trees	890	
Shrubs	600-1000	

Animal Damage Protection

Beaver, nutria, voles, and other rodents can rapidly eliminate tender young trees and shrubs over large areas. To reduce these losses, planters protect seedlings with vexar tubing (photodegradable plastic mesh tubing installed on individual plants) or erosion fencing around large groups of plants, or both. In addition, planting mixtures will include species, which appear to be less prone to damage by rodents; including Oregon ash, conifers, red elderberry, and snowberry.

Mulch

The application of mulch is effective in maintaining soil moisture and suppressing the regrowth of competing non-native vegetation. Mulch is applied in each scalped planting area following plant installation.

Watering

The first two years are critical in the establishment of seedlings. If severe hot and/or dry weather is jeopardizing young plants, sites will be hand irrigated.

Monitoring

BES has prepared monitoring and documentation guidelines for riparian and wetland areas to assess conditions and identify trends to increase continued success of planting projects. Monitoring includes assessment of plant mortality and its causes. BES will interplant areas where stocking falls below a level that will assure occupancy of the site by native plants within 10 years. BES may prescribe other treatments to reduce further plant mortality or to further enhance project areas.

Other Treatments

Particularly steep and unstable banks, may require excavation to a more stable angle prior to planting or stabilization using bioengineering techniques. Other treatments, such as irrigation, exotic plant removal, and broadcast seeding, may be necessary or desirable on particular sites or under certain weather conditions. BES prescribes these treatments on a site-by-site basis.

Five-Year Maintenance

Non-native vegetation will be suppressed by cutting blackberries, reed canary grass and other exotic vegetation with chainsaws, weedeaters, hand tools or industrial mowing equipment. Workers will cut all resprouting exotic vegetation three times during the first year. In years two, three, and five, workers cut brush once or twice in summer, depending on regrowth. BES monitors planting survival and exotic vegetation re-growth, and prescribes additional treatments as needed.

Long-Term Maintenance and Enhancement

At the end of the five-year establishment phase, BES and Landowner will prepare a long-term management plan that will maintain the project and insure the attainment of project goals. Maintenance after the five-year period will be funded by the Landowner. By this time, native trees and shrubs should be established. Stands of young hardwoods and conifers will become very dense, shading out most exotics. Maintenance in these stands should be minimal after five years. Shade tolerant weeds such as nightshade, English ivy, and holly will require continued monitoring and treatment. Areas planted with native shrubs, forbs, and wetland emergent plants will require extended maintenance.

BES and landowners will manage newly established stands in a variety of ways to achieve resource management objectives. Stands may be thinned to lower densities to allow establishment of understory vegetation and to increase growth of individual plants. Small patches within stands may be cut to provide a weed-reduced environment for the establishment of shrubs and forbs, or dense overstory cover may be maintained to minimize additional maintenance and planting costs.

Public Support

As a result of the program's accomplishments, BES has developed a broad base of public support for watershed revegetation. Jim Pierce of Atlas Copco Wagner, Inc. says "Working on this project with BES has been a very positive experience - bridge-building." In an article in their July 17, 1997 edition, Willamette Week calls the program the "Best Use of Local Tax Dollars. ...BES deserves praise for its Columbia Slough Riparian Restoration Project." When asked if he would recommend the program to other businesses, Dave Franks of Miller Paint responded with an enthusiastic "Yes!" Mike

McKay of Laidlaw Transit, Inc. writes, "...this is a wonderful program at reasonable cost."

The program also has strong support from local natural resource and environmental-regulatory agencies. Following a tour of some of the sites restored by the program, Jerry Hedrick of the Oregon Division of State Lands was highly complimentary of the program in a letter to Commissioner Sten. Metro, Portland Parks, Portland Water Bureau, Multnomah County, Oregon Department of Corrections, and Multnomah County Drainage District No. 1 have all participated in the program to install projects.

Accomplishments
The Watershed Revegetation Program has restored 190 riparian acres within the Columbia Slough Watershed, planting approximately 250,000 native trees and shrubs along 16 river miles of the Columbia Slough. Twenty-five acres of wetland habitat has been created, enhanced and/or restored. In addition, over two acres of eroding banks of the slough have been stabilized and revegetated to prevent further bank failure.

3.3.2 Project Costs

The Watershed Revegetation Program has been able to minimize project cost by implementing cost-effective measures. The program operates on a large, industrial scale resulting in wholesale purchasing power for labor, plants and materials. Program savings are passed on to partners of the Watershed Revegetation Program. Cost estimates for projects are listed as 'adjusted costs' in Attachment C.

3.3.3 Outputs

Riparian revegetation, wetland benches, and natural wetlands are intended to collectively improve resource and functional values in the Columbia Slough Watershed. Projects result in an enhanced native plant landscape. This landscape will improve water quality by shading and buffering water surfaces, improving groundwater recharge, increasing flood storage capacity and encouraging biofiltration of sediments. Once established, native vegetation provides habitat and movement corridors for wildlife and increases native plant diversity. In addition, wetland benches will filter and intercept leachate entering the slough and constrict the channel at low flows to increase water velocity and quality.

ATTACHMENT A - ENHANCEMENT PLANT LIST

Upland

Upland and Riparian Trees	Spacing (ft)
Abies grandis	7
Acer macrophyllum	7
Alnus rubra	7
Fraxinus latifolia	7
Populus trichocarpa	7
Prunus emarginata	7
Pseudotsuga menziesii	7
Pyrus fusca	7
Rhamnus purshiana	7
Salix scoulerina	7
Thuja plicata	7
Cornus nuttallii	7

Upland and Riparian Shrubs	
Amelanchier alnifolia	6
Cornus stolonifera	7
Corylus cornuta	6
Oemleria cerasiformis	6
Physocarpus capitatus	6
Ribes sanguineum	6
Rosa nutkana	4
Rubus parviflorus	6
Sambucus cerulea	7
Sambucus racemosa	7

Wetland Scrub/Shrubs

Wetland Shrubs	Spacing (ft)
Cornus stolonifera	6
Fraxinus latifolia	6
Rosa pisocarpa	4
Salix lasiandra	4
Salix piperi	4
Salix sessilifolia	4
Salix sitchensis	4
Spirea douglasii	2

Wetland Pole Cuttings	
Salix lasiandra	2
Salix piperi	2
Salix sessilifolia	2
Salix sitchensis	2

Wetland Emergent

Wetland Emergent Plugs	Spacing (ft)
Eleocharis palustris	.7
Eleocharis ovata	.7
Sagittaria latifolia	.7
Scirpus microcarpus	.7
Scirpus validus	.7
Sparganium emersum	.7
Alisma plantago-aquatica	.7
Glyceria occidentalis	.7
Carex vulpinoidea	.7
Carex aperta	.7
Carex leporina	.7
Carex obnupta	.7
Carex stipata	.7
Carex unilateralis	.7
Elymus glaucus	.7
Juncus acuminatus	.7
Juncus ensifolius	.7
Juncus effusus	.7
Juncus torreyi	.7

Native Emergent Seed*

Carex leporina
Carex obnupta
Carex stipata
Carex unilateralis
Scirpus validus
Alisma plantago-aquatica
Juncus torreyi

Native Grasses

Native Upland Grass Seed*

Agrostis exerata
Bromus carinatus
Deschampsia cespitosa
Festuca rubra var. *rubra*
Hordeum brachyantherum

Native Scrub/Shrub Grass Seed

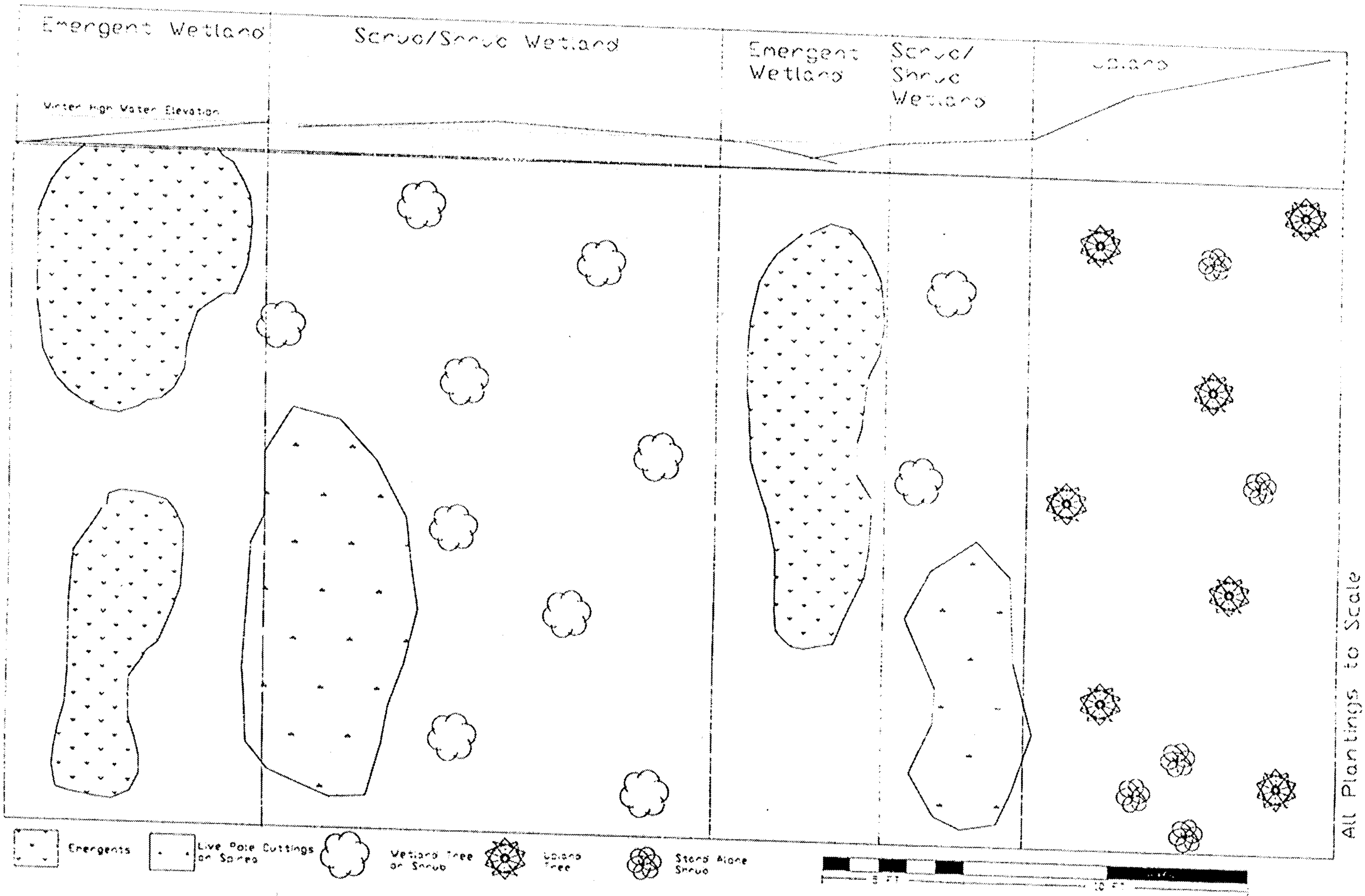
Hordeum brachyantherum

Native Wetland Grass Seed

Beckmannia syzgachne
Deschampsia cespitosa
Glyceria occidentalis
Leersia oryzoides

* Seed mixtures are applied to seeding zones at a rate of 12-15lbs/acres. Various seeding mixtures are used depending on the specific seeding zone conditions.

ATTACHMENT B - "TYPICAL" PLANTING PLAN



Watershed Revegetation Program
WOODY PLANT LIST
1-Mar-00

Trees	Small trees/large shrubs	Shrubs
Bigleaf maple	Black hawthorn	Douglas spiraea
Black cottonwood	Blue elderberry	Longleaf Oregon grape
Douglas-fir	Cascara	Nutka rose
Grand fir	Mock Orange	Tall Oregon grape
Oregon ash	Ninebark	Red osier dogwood
Oregon white oak	Oceanspray	Salmonberry
Red alder	Oregon crabapple	Salal
Pacific willow	Red elderberry	Swamp rose
Piper's willow	Red flowering currant	Swordfern
Ponderosa pine	Serviceberry	Snowberry
Rigid willow	Vine	Thimbleberry
Sitka willow		Twinberry
Western hemlock		
WRC		

Plant Specs:
all plants grown from local Portland metro area seed sources
All plants are bare root seedlings: 1-0, 2-0, or 1-1 transplants
Minimum height 12"
Maximum height 48"
Plant condition:
healthy plants only; no dead tissues, no broken tops or roots
well-balanced shhot to root ratio. Root length 10-12", fibrous.
Multiple buds, full foliage on evergreens

ID	Species
WRP-107	Achillea millefolium
WRP-108	Achillea millefolium
WRP-94	Agrostis alba
WRP-63	Agrostis exarata
WRP-64	Agrostis exarata
WRP-65	Agrostis exarata
WRP-95	Agrostis exerata
WRP-96	Agrostis exerata
WRP-66	Aleopecurus geniculatus
WRP-109	Alisma plantago-aquatica
WRP-110	Alisma plantago-aquatica
WRP-111	Alisma plantago-aquatica
WRP-112	Alisma plantago-aquatica
WRP-113	Alisma plantago-aquatica
WRP-114	Alisma plantago-aquatica
WRP-115	Alisma plantago-aquatica
WRP-116	Alisma plantago-aquatica
WRP-117	Alisma plantago-aquatica
WRP-118	Alisma plantago-aquatica
WRP-119	Anaphalis margaritacea
WRP-120	Aquilegia formosa
WRP-121	Aster chilensis var. Hallii
WRP-67	Beckmania syzigachne
WRP-68	Beckmannia syzgachne
WRP-69	Beckmannia syzgachne
WRP-97	Beckmannia syzgachne
WRP-98	Beckmannia syzgachne
WRP-99	Beckmannia syzgachne
WRP-70	Bromus carinatus
WRP-71	Bromus sitchensis
WRP-72	Bromus vulgaris
WRP-21	Carex amplifolia
WRP-22	Carex aperta
WRP-23	Carex aperta
WRP-24	Carex aperta
WRP-25	Carex aperta
WRP-26	Carex deweyana
WRP-28	Carex obnupta
WRP-29	Carex stipata
WRP-30	Carex stipata
WRP-31	Carex stipata
WRP-32	Carex tumulicola
WRP-33	Carex unilateralis
WRP-34	Carex unilateralis
WRP-35	Carex unilateralis
WRP-36	Carex vesicaria
WRP-37	Carex vulpinoidea
WRP-38	Carex vulpinoidea
WRP-39	Carex vulpinoidea
WRP-40	Carex vulpinoidea
WRP-73	Danthonia californica

WRP-74	Deschampsia caespitosa
WRP-75	Deschampsia caespitosa
WRP-76	Deschampsia caespitosa
WRP-77	Deschampsia caespitosa
WRP-100	Deschampsia cespitosa
WRP-78	Deschampsia elongata
WRP-41	Eleocharis ovata
WRP-42	Eleocharis ovata
WRP-43	Eleocharis palustris
WRP-44	Eleocharis pulustris
WRP-101	Elymus /Bromus Mix
WRP-79	Elymus glaucus
WRP-80	Elymus glaucus
WRP-81	Elymus glaucus
WRP-82	Festuca occidentalis
WRP-102	Festuca occidentalis
WRP-83	Festuca romeri
WRP-84	Festuca rubra
WRP-85	Festuca rubra
WRP-86	Festuca rubra
WRP-87	Festuca rubra v. rubra
WRP-88	Festuca rubra/Elymusmix
WRP-89	Glyceria occidentalis
WRP-90	Glyceria occidentalis
WRP-103	Glyceria occidentalis
WRP-104	Glyceria occidentalis
WRP-91	Hordeum brachyantherum
WRP-92	Hordeum brachyantherum
WRP-105	Hordeum brachyantherum
WRP-45	Juncus acuminatus
WRP-46	Juncus acuminatus
WRP-47	Juncus ensifolius
WRP-48	Juncus oxymeris
WRP-49	Juncus tenuis
WRP-50	Juncus Torreyi
WRP-51	Juncus Torreyi
WRP-52	Juncus Torreyi
WRP-93	Leersia oryzoides
WRP-106	Poa compressa
WRP-53	Scirpus microcarpus
WRP-54	Scirpus microcarpus
WRP-55	Scirpus microcarpus
WRP-56	Scirpus microcarpus
WRP-57	Scirpus validus
WRP-58	Scirpus validus
WRP-59	Scirpus validus
WRP-60	Scirpus validus
WRP-61	Scirpus validus
WRP-62	Scirpus validus

APPENDIX C

Section 404 (b) (1) Evaluation

SECTION 404(b)(1) EVALUATION
COLUMBIA SLOUGH SECTION 1135
HABITAT RESTORATION
MULTNOMAH COUNTY, OREGON

I. Introduction

Section 404 of the Clean Water Act of 1977 requires that all civil works projects involving the discharge of dredged or fill material into waters of the United States be evaluated for water quality effects prior to making the discharge. This evaluation assesses the affects of the fill material placed into the Columbia Slough, tributary to the Willamette River.

II. Description of the Proposed Activity

The proposed action is to provide ecosystem restoration in Columbia Slough by improving water quality and creating wetlands. This action involves dredging 44,900 cubic yards (CY) of sediments from the slough between rivermiles (RM) 8.5 and 16, creating 9 acres of wetland benches within the slough, and creating a total of 1.0 acre of new riparian scrub-shrub habitat, 11.3 acres of emergent wetland habitat, and 1.7 acres of aquatic bottom habitat; restoring 18 acres of adjacent wetland, and replacing five culverts in Buffalo Slough and Whitaker Slough to facilitate water flow, lower water levels, and create 19.7 acres of emergent wetland habitat (Figures 3a and 3b) Most of the excavated material would be used to create the wetland benches.

The physical environment of present-day Columbia Slough between RM 8.5 - 16 would be altered. The excavation of about 44,900 cubic yards (cy) of sediment would be excavated, deepening the channel from elevation 6'CRD (Columbia River Datum) down to elevation 3' CRD in the upper slough (upstream of the mid-dike levee), and from elevation 5' CRD down to elevation 2'CRD in the middle slough. Most of this material would be placed on the bank side of the channel to form wetland benches. The material would be dredged in two lifts, with a barge-mounted bucket dredge skimming off the top 12"-18", placing it on the side of the channel. Material would then be dredged from a lower level and carefully placed on top of this material. These benches would be about 20 feet wide, with varying lengths on each side of the slough channel. The estimated total surface coverage is about 9 acres. Deepening and narrowing the channel would accelerate water flow, reducing stagnation. During the excavation and placement of material, short-term turbidity is expected to occur. Water management techniques would be employed to temporarily stop or reduce flow until the sediments settled out.

Sediments within the slough will be handled so that "top" material dredged from undisturbed channel will be on the bottom of the piled material creating the bench. The excavation will be done with shallow cuts to get the top material on the bottom of the disposal site. Material will be placed rather than dumped. Placing excavated material top down would reduce the probability that sediments containing DDT would enter the water system. Placement of material on top of existing sediments with DDT also keeps those sediments from contributing DDT to the system in the future. DDT in the sediments to be excavated does not exceed screening levels; however, it is beneficial to cover these sediments so that any DDT is less likely to become available in the ecosystem.

An estimated 3,600 CY of excess dredged material would be placed in 4-inch to 6-inch layers on the landward side of the main Columbia River levee along NE Marine Drive between NE 42nd Street and the I-205 bridge. The excess material will not have any direct contact or possibilities of running back into a waterway without first draining through several bio-swale systems, in order to filter out any sediments.

Replacement of four corrugated metal pipe (CMP) culverts with reinforced concrete pipe culverts on Buffalo Slough at Broadmoor and on Whitaker Slough at Colwood Golf Courses, together with installation of a 48" HDPE (high-density polyethylene) Spirolite culvert beneath NE 33rd Avenue, would involve excavation of 785 cy of material and placement of about 865 cy of material. About 185 cy of Class 100 rip rap per culvert , covering about 200 sq.ft. of surface area per culvert (1,000 sq. ft. total) would be placed to prevent erosion. Temporary cofferdams may be necessary during construction.

III. Description of the Discharge Site

Columbia Slough is a tributary to the Willamette River near its confluence with the Columbia River. The fill location corresponds to approximately RM 108.5 to RM 116 of the Columbia River. Columbia Slough is about 18 miles long and is located just south of and parallel to the Columbia River in a highly developed industrial and residential area of north Portland. Levees and embankments constructed in the early 1900's cut off flushing from the Columbia River and divided the slough into two parts. The slough does not meet Oregon Department of Environmental Quality requirements, suffering from stagnation, accumulation of industrial pollutants and toxic chemicals. Sediments are predominantly sand in the lower portions, changing to silt further upstream. Aquatic life consists predominantly of oligochaete worms in the benthos, some aquatic invertebrates, and various fish. Game fish include crappie, sunfishes, and white sturgeon. Juvenile chinook salmon are occasionally found during late spring high water conditions on the Willamette River. Non-game species include sucker, carp, stickle back, pea mouth and cottids.

IV. Factual Determinations

a. Physical Substrate Determinations

The substrate of the fill site is primarily silt and sand.

b. Water Circulation, Fluctuation, and Salinity Determinations

The fill action would have little or no effect on water fluctuation or salinity. With the deepening and narrowing of the slough and replacement of culverts, circulation should improve.

c. Suspended Particulate/Turbidity Determination

Placement of 44,900 CY of dredged material would result in minor, short-term turbidity in Columbia Slough. The discharge itself is expected to meet State water quality standards; however, minor amounts of bottom sediments in the slough may be disturbed by the increased flow until the new regime stabilizes.

d. Contaminant Determinations

Sediments in the middle portion of the slough are primarily silts and silty sand. Analysis from 1999 sampling (see Appendix A) indicates that sediments are composed of more than 20 percent fines, with some samples exceeding 5 percent volatile solids.

Historical data from the main Slough were reviewed to evaluate potential sediment issues related to in-water disposal (side casting) of Slough sediments. Most of the surface samples were below the screening levels (SLs) of the regional Dredge Material Evaluation Framework for the Lower Columbia River Management Area (DMEF). Additional sampling was conducted by the Corps of Engineers to characterize the sediment of portions of the middle and upper Columbia Slough mainstem (Appendix A). The chemical testing indicated that the only contaminant exceeding the DMEF screening levels was DDT. DDT levels were highest upstream of the 'Four Corners' area near MCDD Pump Station #4. Source of the DDT is probably historic spraying for mosquito control as well as agricultural use. Subsequent biological testing indicated no risk for bioaccumulation in wildlife or humans. The wetland benches are proposed to end at NE 158th, downstream of this area.

Sediments in Columbia Slough downstream of the proposed action may contain contaminants. As these sediments are disturbed by and re-enter the water column, there could be a temporary increase in water-borne contaminants. These would be expected to re-settle within a short period of time.

e. Aquatic Ecosystem and Organism Determinations

Adverse impacts to the structure and function of the aquatic ecosystem and organisms would be minor and short term in nature. In-water work would be scheduled to comply with Oregon Department of Fish and Wildlife preferred work period, which is June 15 to September 15, or as otherwise agreed to. Provision of restored wetland, wetland benches and cooler, faster-flowing water would improve the aquatic ecosystem, including providing increased quantity and quality of available habitat for native turtles.

f. Proposed Disposal Site Determinations

Placement of dredged material in Columbia Slough would not violate Environmental Protection Agency or State water quality standards, except for a short duration during placement. Placement of sediments would not introduce new substances into surrounding waters or violate the primary drinking water standards of the Safe Drinking Water Act (42 USC 300 et seq.).

g. Determination of Cumulative effects on the Aquatic Ecosystem

The proposed action is not expected to have significant adverse cumulative effects on the aquatic ecosystem. Provision of restored wetland, wetland benches and cooler, faster-flowing water would improve the aquatic ecosystem.

h. Determination of Secondary Effects on the Aquatic Ecosystem

The proposed work would not cause any lasting negative secondary effects on the aquatic ecosystem. There could be some minor disturbance of existing sediments in the slough during placement of the dredged material and during flow events. Sediments that re-enter the water column are expected to settle out in the immediate area.

V. Coordination

The environmental restoration report/environmental assessment desribing the proposed action is the main report to which this Section 404(b)(1) is attached as Appendix C, and is under concurrent review. The proposed action was coordinated with appropriate Federal, State, and local resource agencies, organizations, and interested members of the public through issuance of Public Notice. State water quality certification is requested concurrent with review of the report/environmental assessment.

VI. Findings of Compliance or Non-Compliance with the Restrictions on Discharge

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. The "no action" alternative was considered and rejected because it would not be responsive to wetland restoration needs in the area.

c. The proposed action is in compliance with applicable State water quality standards.

d. The proposed action would not violate the toxic effluent standards of Section 307 of the Clean Water Act.

e. The proposed action would have no effect on threatened or endangered species or their critical habitat. The Corps has determined that the project would have no effect on bald eagles, or listed salmonids. A biological assessment concluding no effect was submitted to the U.S. Fish and Wildlife Service. The proposed action would improve quantity and quality of available habitat for the western pond turtle and the painted turtle, listed as Sensitive Critical in Oregon.

f. The fill would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, and wildlife. Significant adverse effects on aquatic ecosystem diversity, productivity, and stability, and recreational, esthetic, and economic values would not occur.

g. Appropriate steps to minimize potential adverse impacts would be specified in the construction contract.

With the inclusion of appropriate and practical conditions to minimize pollution and adverse effects to the aquatic ecosystem, the proposed action is specified as complying with the requirements of the Section 404(b)(1) guidelines.

Date: ______________

RANDALL J. BUTLER
Colonel, EN
Commanding